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**ASSISTANCE IN POLLUTION CONTROL IN THE
TANNING INDUSTRY IN SOUTH-EAST ASIA**

Report of in-depth evaluation mission*

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Abbreviations and acronyms:

AISHTMA	All India Skin & Hides, Tanners and Merchants Association
APKI	Indonesian Association of Tanners
BAPEDAL	Agency for Environmental Impact Assessment (Indonesia)
CETP	Common effluent treatment plant
CLRI	Central Leather Research Institute
CRP	Chrome recovery plant
CTC	Centre Technique de Cuir, Chaussure et Maroquinerie, (Lyon, France)
EMS	Environmental Management System
EIP	Effluent treatment plant
ILIFO	Indian Leather Industry Foundation
IRDLAI	Institute for Research and Development in Leather and Allied Industries (Yogyakarta)
MOU	Memorandum of Understanding
NBSM	Nepal Bureau of Standards and Metrology
NLITA	Nepal Leather Industry and Trade Association
OSH	Occupational Safety and Health
PDU	Pilot and demonstration unit
RePO	Regional Programme Office (Chennai at TNPCB)
RO	Reverse Osmosis
SME	Small-scale and medium-sized enterprises
sq.ft.	Square feet
TCDC	Technical Cooperation between developing countries
TDS	Total dissolved substances
TNSPCB	Tamil Nadu State Pollution Control Board
UASB	Upflow anaerobic sludge blanket

Monetary units:

India	Indian Rupees (INR)	1 US\$ = 42.87 INR
Indonesia	Indonesian Rupiah (IDR)	1 US\$ = 6,345 IDR
Nepal	Nepalese Rupees (NPR)	1 US\$ = 68.00 NPR

SUMMARY

In all the countries where the programme has been implemented the activities in the field of pollution control, effluent treatment and waste management were required by the leather tanning sector. The launching of the programme was timely, in particular in India, where more than 400 tanneries were closed down in 1995, because of violation of the environmental laws.

The various measures and activities undertaken under the Programme addressed the urgent problems faced by the tanning industry in the region at the time the Programme was introduced. The activities implemented are still addressing acute problems. Hence, their relevance has been recognised by the industry.

The programme can be judged as a success, since it was able to implement pollution control measures and in-house improvements in leather tanneries and their agglomerations, one of the most important industrial sectors in the region through a suitable and comprehensive approach. This approach is characterised by doing the right things at the right time (improvement of effluent treatment plants) and creates *know-how* through *show-how* (Pilot and Demonstration Units). The technical performance and work quality including the management are evaluated as excellent. In some aspects the achievements of the programme even exceed the original planning.

Increased awareness relating to environment, OSH, gender issues, eco-labelling, and related matters is a clearly visible effect in all countries. Tanners are better prepared to react on and comply with customer requirements and government regulations, and in all countries the preparedness of tanners in these respects has been notably enhanced.

The capabilities of tanners to assess their requirements in respect of cleaner technologies, environmental management, and OSH related matters have been enhanced. Numerous tools and methods to improve pollution control and meet legal and other requirements demonstrated as options for direct use in the companies or as common facilities are in the process of being completed. Further efforts towards wider diffusion of important achievements under the programme will help the tanning industry in the region on a broader basis. Demonstrated OSH measures and low waste techniques are a starting point for improvement in the companies throughout the region.

The technical information generated by the programme has been found to be of very high quality. The programme has started disseminating results, facts, procedures and information through seminars, workshops, training, printed material, and other tools. The programme has been successful in propagating cleaner technologies as well as the much-required end-of-pipe measures, with the result that the partners/beneficiaries gained advantage and improvement on both “ends of the pipe”.

Due to the very difficult work environment in tanneries as well as to other reasons, enhancing employment of women in the tanning sector did not achieve significant success. However, with improving work environment in tanneries with the introduction of effective OSH measures, the situation will change in the future. With respect to eco-labelling, UNIDO activities in harmonising different country approaches are steps in the right direction; however, no big efforts are required in future.

Though Pilot and Demonstration Units implemented are relevant to the urgent needs of the tanning industry, they are more oriented towards end-of-pipe treatment rather than to the process itself or aligned to waste minimisation at the source. A few PDUs were too much research oriented and, thus, not of large relevance for the tanning industries, in particular for the SMEs.

Chrome management in tanneries has been given due importance, in particular by chrome recovery. However, uncontrolled discharge of chromium by treated effluents, solid wastes, and sludge still is a problem. The hazardous potential of chromium (in its trivalent stage) has not yet been fully recognised, as it seems. Yet, the dilemma with chrome discharges is a very difficult issue and needs further activities and development of solutions everywhere in the world.

The immense number of technical reports and publications and the PDUs represent the high amount of technology transfer achieved. The project not only absorbed professional inputs to produce the planned outputs in the field, but, it also processed and documented the experiences and the advances achieved in technology application and, thus, contributed to the stock of knowledge and technological progress in this sector.

It is highly recommended to continue this programme, finalise the already started dissemination process, intensify the demonstration of new pollution control techniques, cleaner production, as well as continue with demonstrating improved and uncomplicated (clever) end-of-pipe techniques.

A more process oriented approach using clean technologies, with accent on improving productivity and quality of leather in tanneries and end-of-pipe measures should be combined to form a complete holistic approach towards cleaner leather production. This will lead to wider acceptability and is appropriate for meeting present and future market and legal requirements. In this regard laying greater emphasis on simple and inexpensive improvements thereby providing immediate cost benefits to the companies will help to build confidence and make it easier to proceed to essential but large and long-term investments.

All viable achievements should be consolidated mainly by further dissemination activities in various forms (training manuals, etc.) so that this vital information will be accessible to tanners in South East Asia and any part of the world.

Future needs and still remaining fields for improvement in the tanning industry should be identified systematically, prioritising the needs carefully with due consideration to present and future market requirements, legal and social needs, and industry's own capability. Introduction of Environmental Management Systems (EMS) for the tanning industry as an organisational tool for implementation of cleaner production, and, thus, reduction of production costs and improvement of quality should be included in the programme. End-of-pipe treatment technologies should still be recognised, since they are inevitable tools in a sector where zero-emission is by no means achievable.

The sustainability of common and individual effluent treatment plants (ETP/CETPs) depends on the efficiency of enforcement mechanisms, global market requirements, and societal pressures. These factors vary from country to country. In India where these are pronounced, the sustainability of ETP/CETPs is virtually ensured. However, where these factors are absent or weak, such as in Nepal or Indonesia, the sustainability will have to depend entirely on the positive attitude of the beneficiary. Counterpart government agencies should take note of this and initiate necessary steps to ensure that the facilities created are fully operated.

Overall sustainability of the key results of the programme will be better safeguarded, when the Indian Leather Industry Foundation (ILIFO) takes over the programme activities after its conclusion. This organisation will require adequate strengthening. A clear-cut strategy and plan of action and a necessary support system should be drawn up.

In all the countries the industry as well as counterpart government organisations specifically requested continuation of the programme for three more years or more to enable these countries to overcome their problems. The programme may use this credibility factor to advise the concerned

enforcement agencies and environment management departments of the government on appropriate measures to improve overall environment management in the industry.

In order that the recommendations outlined above are realistically achieved, it is foreseen that the programme will have to carry on its activities, at least, for three more years. The programme must immediately prepare a successor phase document, based on the conclusions and recommendations made in this report. The focus, as brought out in this report, must be on consolidation, replication, diffusion, and assured sustainability.

1. INTRODUCTION

1.1 *Scope of the Evaluation*

1.1.1 This in-depth evaluation covers the regional umbrella programme US/RAS/92/120, 'Assistance in Pollution Control in the Tanning Industry in Southeast Asia', and its associated country projects. The regional programme and the country projects were originally conceptualised by UNIDO in 1988, and formulated by 1992. It was not until March 1996 that full donor funding was secured for the projects and the overall programme activities commenced on a full-fledged basis. The programme is envisaged to last for five years, and the country projects were planned for completion in a period of between 2 and 3 years from the respective date of commencement of each country project. The evaluation concentrates on reviewing the results achieved under the five objectives of the programme, i.e.:

Containment of environmental degradation emanating from the tanning industry in five selected countries in Southeast Asia;

A significant reduction in the amount of pollutants generated in the process of leather manufacture in a number of tanneries in the five selected countries of South East Asia;

Increase women's contribution and their effective integration in the activities of leather industry sector in the region, with particular emphasis to environmental aspects;

Improvement of Occupational Health and Safety (OSH) at work standards in the tanning industry in the countries participating in the regional programme;

Reduction of the environmentally harmful impact of the leather industry and better protection of consumers through a voluntary scheme of process and product based labelling for leather and for leather products (eco-labelling).

1.1.2 The original conception of the regional programme, US/RAS/92/120 "Assistance in Pollution Control in the Tanning Industry in South East Asia B Rev. I", involved India, Indonesia, Nepal, China, Sri Lanka, and Thailand. Eventually the national project in Thailand did not materialise as donor's funding had been withdrawn. Given the fact that the number of participating countries were reduced, this evaluation covers the regional programme and three complementary national projects implemented, more or less concurrently, in India, Indonesia and Nepal. The complementary national projects were:

US/IND/ 97/124 Assistance in treatment of tannery effluent in the state of Tamil Nadu, India - Phase II. Tertiary treatment and utilisation and disposal of sludge;

US/INS/92/120 Assistance in pollution control and effluent treatment in two selected areas of Indonesia.

US/NEP/92/120 Establishment of model and demonstration tannery effluent treatment facilities in Nepal.

1.1.3 This evaluation does not deal at any length with a complementary national project in China (US/CPR/92/120 - Assistance in pollution control and treatment of tannery wastes in selected areas of China) as that was subjected to a separate in-depth evaluation in 1996. Furthermore, some

activities of the regional programme, in particular its training programmes, benefited institutions and representatives from industry from Bangladesh, Pakistan, the Philippines, Sri Lanka, Thailand and Vietnam.

1.1.4 It was not within the Terms of Reference of the evaluation to assess the beneficiary impact of the programmes training activities undertaken for the benefit of the industry and institutions in those countries. **Appendix 1** contains the Terms of Reference of this evaluation.

1.2 Composition of the Evaluation Team

1.2.1 J. Porst, UNIDO Consultant, and S. A. Hasnain, UNIDO Representative in Indonesia (hereinafter referred to as the evaluation team) undertook the evaluation. In India, Mr. S. Jawahar, an independent national consultant engaged by UNIDO for the evaluation activities in that country joined the evaluation team. During the field missions, the individuals and officials listed in **Appendix 3.1** supported the evaluation team.

1.2.2 The evaluation team wishes to record its deepest gratitude to the above mentioned individuals for the time they devoted to the conduct of the evaluation.

1.3 Timing, Methodology of the Evaluation:

1.3.1 The evaluation was conducted between 8 June and 16 July 1999 in the following phases:

UNIDO Headquarters? briefing of J. Porst on 8 June in Vienna;

Home-based work of mission members (review of documents);

Field fact finding missions and on-site review of programme outputs: INDONESIA (Yogyakarta); INDIA (Chennai); NEPAL (Kathmandu, Birgunj); INDIA (Chennai, New Delhi, Ranipet, Vaniyambadi, and Ambur); 14-25 June;

Preparation of preliminary findings by the evaluation team, Chennai, 26-27 June and departure of S. A. Hasnain;

Further review of programme outputs and presentation of preliminary evaluation findings, at ILIFO in Chennai, by J. Porst, 28-30 June;

Presentation at UNIDO Headquarters of preliminary findings by J. Porst, 2-3 July, Vienna;

Finalisation of report by the team in Vienna, 12-15 July and afterwards by J. Porst.

1.3.2 The evaluation is based on the following elements:

A review of project literature received from UNIDO Vienna, UNIDO RePO in Chennai, and UNIDO field offices in Kathmandu and Jakarta;

A comprehensive briefing by RePO staff in Chennai on 16 and 17 June;

Field visits to project demonstration sites in India (Ambur, Chennai, Ranipet, Vaniyambadi), Indonesia (Yogyakarta) and Nepal (Birgunj);

Meetings and in-depth discussions with industry, counterpart organisations and institutional

beneficiaries of different components of the programme in all three countries; and

A few meetings with the field-level management of projects undertaken by UNDP and bilateral development co-operation agencies, which have a potential relationship to the present programme in India.

1.3.3 The evaluation team met with more than 50 individuals, visited more than 10 enterprises and 7 institutions during the field visits in the three countries. The schedule of meetings and activities undertaken during the field visits to Yogyakarta, Chennai, Ranipet, Ambur, Vaniyambadi, New Delhi, and Kathmandu/Birgunj, is attached as **Appendix 2**. A list of selected individuals met is attached as **Appendix 3.2**.

1.3.4 As the evaluation was conducted at a point when the national projects were in the last period of implementation - the projects are scheduled to end by December 1999 and the regional programme enters its last year - the results of the review are fairly complete reflections of the overall programme achievements. The time remaining before programme completion may enable some aspects of the country projects to benefit from the changes in strategy advocated here, thereby enhancing the effectiveness of those aspects of the projects concerned.

2. PROJECT CONCEPT AND DESIGN

2.1 Socio-economic Context

2.1.1 The South and South East Asian region constitutes a major source of raw material for the Leather and Leather Products industry, accounting for between 20% and 60% of world supply of raw hides and skins - depending upon the commodity under consideration. The industrial development of these countries over the last two decades has featured the tanning industry as an important component of their industrial structure, with this industrial branch emerging as a significant, source of export income, as well as a base for a growing domestic leather products industry. Given its specific environmental impact, especially on the utilisation and degradation of land and water resources, environmental concerns pertaining to the tanning industry have been increasing over the last fifteen years or more, and the implementation of environmental protection measures by the industry will remain an imperative over the foreseeable future.

2.1.2 Furthermore, as the processing of leather involves technologies of different vintages as well as physical/mechanical and chemical transformation of raw materials, there is a need for the industry to consistently adopt management measures to foster safety and health in the workplace and the surrounding areas and water bodies.

2.1.3 Thirdly, although the industry is not particularly labour intensive, its sheer importance in Asian economies warrants an examination of the scope for engendering the employment of women in this branch. Finally, consumer and customer concerns on the environmental friendliness of products have inspired the establishment of technical (e.g. PCP, azo-dyes, Cr(VI)), and voluntary environmental standards such as eco-labels for leather and leather products in some important developed country markets. The establishment of a balanced set of international criteria for eco-labelling may create a basis on which environmental concerns may be accommodated without placing a barrier to trade which would disadvantage developing country exporters.

2.1.4 In the countries covered by the evaluation, the tanning industry faces pressure, albeit to

varying degrees, from domestic government and export customers to improve environmental performance as well as conditions of work. Also, in recent times increasing local pressure by community and environmental groupings has been witnessed in some areas, as the industry sometimes imposes environmental and safety hazards on scarce land and water resources not only in areas of dense population. Despite these common features, there are significant differences among the industries of the three countries concerned, and an overview of the specific characteristics would help set the backdrop for this evaluation.

India:

2.1.5 India has some two-and-a-half thousand tanneries, producing 1.7 billion sq.ft. per annum of different types of leather. Over the last decade the industry has grown at an annual average rate of 13 %, as it ascended the value chain, as well as expanded the volume of output. The industry is primarily concentrated in a few States - Tamil Nadu (mainly Chennai, Ranipet, Ambur and Vaniyambadi), West Bengal (Calcutta), Punjab (Jullundar) and Uttar Pradesh (Kanpur and Agra) - although the industry exists, in one form or the other, in almost all other states. About sixty per cent of the production capacity is located in Tamil Nadu. As mechanised tanning has been present for about two centuries in the country, the leather industry spans the spectrum of technologies and types of production - the large, modern sector accounts for about 40% of physical output, mechanised SMEs for another 50% and small artisanal and unorganised sector accounts for about 10% of output. Like the rest of the economy, the Indian leather industry is experiencing a process of gradual liberalisation from the stringent protectionism and import substitution policies followed until the mid nineteen eighties. Despite the liberalisation, the industry is still very sensitive and concerned with fiscal incentives, especially as regards exports. The industry is a major exporter, attaining an export value of INR 69 billion (US\$ 1.6 billion) in fiscal year 1998-99. Between April 1998 and January 1999 the Indian leather exports increased by 3.68 % in terms of US\$. The reason lies in improved quality of leather products and shoes.

2.1.6 The concentration of the industry in specific states and in a few locations in those states makes it a fairly visible source of pollution, and it is facing increasing and sometimes powerful pressures from State and Central Governments, environmental groups as well as civil society to contain its environmental impact. The federal and state level environmental and pollution control authorities have adopted mandatory discharge standards, which are enforced with varying degrees of rigour. The State of Tamil Nadu, in particular, has undertaken strong enforcement programmes. In 1996, the Supreme Court of India adjudicated a decision whereby the tanners of Tamil Nadu were required to stop releasing untreated effluent, or face closure of factories. A total of more than four hundred factories were closed as a result of this judgement. 150 of the closed units have since resumed operations, but only after having satisfied the State authorities that they have installed their own effluent treatment plants or are participants in common effluent treatment plants along with other tanneries. Furthermore, in Tamil Nadu, the export orientation of the tanning industry is subjecting it to increasingly stringent customer requirements in foreign markets to ensure improved environmental performance as well as working conditions, according to customer standards.

Indonesia:

2.1.7 The tanning industry in Indonesia also enjoys long-standing position. Over the past decade and a half, with the remarkable investment-driven growth of the Indonesian economy, the leather industry expanded. The industry consists of about 50 to 100 large-scale and medium-sized units. Much more are small and micro enterprises, with basic levels of mechanisation, and a very small turnover. However a few large-scale modern units were installed, some as joint ventures with foreign partners, relying on more advanced technology and economies of scale to enter export

markets. Medium and large-scale tanneries account for about 50% of the value of the output of the leather sector. The tanning industry is mainly concentrated in the island of Java, in the capital city of Jakarta, Yogyakarta and Surabaya/Magetan in Central Java and Bandung/Garut in West Java, although there is an active hides and skins trade as well as some tanning activity is undertaken in Sumatra as well as other islands.

2.1.8 Until the South East Asian crisis of mid 1997, the leather industry was among the larger sectors of Indonesia's industrial structure, serving an export oriented domestic leather products sector, as well as exporting directly to external markets. The crisis of 1997 reverberated through the industry and exerted a deleterious impact on the industry, as it faced adverse business circumstances due to:

An acute credit crunch resulting from enormously high domestic interest rates and the difficulty of obtaining letters of credit for exporters;

A three- or fourfold rise in costs of tanning chemicals and finishing materials with the drastic depreciation of the Indonesian Rupiah. The bulk of tanning chemicals and finishes are imported;

An equivalent rise in domestic prices of hides and skins since the exports of these were freed from export duties and levies under the IMF structural adjustment programme. The supply of hides was also aggravated by shortages caused by the collapse of the beef feedlot industry, which relied on imported cattle; and

Loss of external customer confidence in the capacity of the industry to meet export orders due to the political and social instability witnessed since May 1998.

2.1.9 Despite these acute setbacks, as of this writing the Indonesian economy is experiencing a gradual economic stabilisation, and it is anticipated that the tanning industry will adjust to circumstances and resume a gradual return to its previous growth path.

2.1.10 As Java, an island about the size of New York State, is simultaneously the hub of industry, home to about sixty per cent of Indonesia's two hundred million people and the main producer of rice in Indonesia, it faces long term pressures on its land and water resources from competing claims of urban development, agriculture and industry. In addition, threats to the surrounding rich marine bio-diversity pose an imperative on environmental protection from the adverse impact of urban development, industry, and a chemicals-dependent agriculture. Environmental concerns have therefore been fairly prominent in recent national development policy, as well as in multilateral and bilateral development co-operation programmes in Indonesia.

2.1.11 The Ministry of Environment and its Agency for Environment Impact Assessment (BAPEDAL) have issued environmental standards, including effluent discharge standards for the tanning industry, among others. However the Government's monitoring, supervision and enforcement capabilities are weak. Environmental protection in industry, in large part, relies more on voluntary measures than Government enforcement. The voluntarism is prompted by external customer pressure or the corporate policy of joint venture partners. More recently the pressures from citizens or environmental groups have been increasing, forcing the closure of a few enterprises (in the pulp and paper and rayon industry) in the face of sometimes violent public protest. Another voluntary stimulus is due to the mere desire of enterprises to be viewed as good corporate citizens. All these pressures are somewhat weak motivations, given the magnitude of the environmental problems faced by the country.

Nepal:

2.1.12 Nepal, as a least developed and landlocked country, has a very limited industrial base. The tanning industry consists of some sixteen industrial units, concentrated in Birgunj in the Southwest and Biratnagar in the east. While two or three of the enterprises can be bracketed in the medium to large-scale categories, the rest of the industry consists of small-scale units, with a basic degree of mechanisation. One or two of the industries export directly to European markets, and the rest either fulfil domestic demand or export to Indian customers in Uttar Pradesh or Bihar. The fragile Himalayan ecosystem of the country faces its main environmental stress on water and land resources from tourism and the growth of population. The pollution of rivers has assumed a trans-boundary dimension, due to the downstream flow of rivers into the Indian plains. Environmental concerns have been voiced for some time by the Government, and recently discharge standards on tannery effluents were adopted by the Government and they await the formal enactment through gazetting by the Ministry of Environment. Due to the paucity of resources, Governmental capacities to enforce standards are presently extremely weak, and industry's conforming to those standards will be determined almost entirely due to customer requirements or to voluntary initiatives.

2.1.13 By nature, tanners are very conservative. This is not simply obstinacy against change; it is because the quality and character of leather is prone to change when the parameters of processing are altered. Leather being produced from a complex, non-uniform natural protein material still requires considerable craft in its manufacture. The adoption of low waste technology sometimes requires a change of tannery processes, while, at the same time, ensuring that the ultimate product retains its marketable properties. Therefore, if a tanner is producing consistent quality of leather, which satisfies his customers using a process, which is wasteful in water, energy, and chemical utilisation, he may resist altering his operations to comply with environmental demands. It is one of the objectives of this programme to overcome these obstacles.

2.1.14 Traditionally, in developing countries in South East Asia tanning operations are a family business, carried out in small to medium scale semi-mechanised units, very frequently grouped tightly in clusters which used to be outside residential areas. Tanners in such units have no formal education and have little or no understanding of the complexities of the leather processing, their skills acquired from the elders with hardly any perception of environmental protection. These conditions are in the course to undergo a change, a development, which is only starting now, and which can be studied in the medium-sized and larger tanneries also in India, where progressive thinking is getting ground.

2.1.15 Low waste technologies, generally speaking, require better skilled personnel and closer technical control than conventional processing. Thus, the lack of properly trained staff at different levels remains one of the crucial constraints. Pollutant discharge standards in most developing countries are by nature rigid and have a disregard for specific site conditions. Often a tanner is under pressure to put up a complete treatment system and meet all discharge limitations at once, which is beyond his financial and technical means, whereas a step-by-step approach would be more helpful.

2.1.16 In addition to the regular process and quality control common laboratories must be able to measure specific pollution parameters. However, very few tanners have the necessary process and effluent treatment control facilities; legislation enforcement agencies usually lack skilled personnel to monitor the performance of the installed treatment plants. Thus, the means for proper enforcement are essential. If legal enforcement of the standards is not put into effect, it is understandable that the required environmental standards may not be observed.

2.2 Institutional Framework

2.2.1 As noted in the original project document (US/RAS/92/120 & US/RAS/92/120, Rev.1) there is no formal regional or sub-regional institutional framework for the programme, although several institutions and organisations are playing a role in examining regional environmental issues (various regional or sub regional programmes of the UN system, ESCAP, the regional or sub regional offices or programmes of bilateral agencies such as DANIDA and GTZ). The regional dimension of this programme emanates from the opportunities created for sharing of experiences at the levels of institutions, enterprises, and individuals (as well as technologies). The institutional foundation, therefore, rests primarily on the participating national counterpart institutions and the extent to which they are capable of liaising with and mobilising their respective industry associations and drawing on the results of the regional programme for the benefit of national efforts. The associated national institutions in the three countries are listed in **Appendix 4** for the sake of completeness.

2.2.2 The national institutions are involved in varying degree in establishing, promoting the use of, and supervising compliance to national environmental standards. In addition, a couple of the counterpart institutions are entrusted with the task of developing, testing, adapting and diffusing technology in the tanning industry - a function carried out with varying degree of success in the countries concerned. The counterpart support institutions and the industry and its representative associations, in the case of India and Nepal, as witnessed by the evaluation team, have increasingly shared the ownership of the project. As discussed below, in the case of Indonesia, a lukewarm sense of ownership impeded the attainment of project results.

2.2.3 In addition to these national institutions, several multilateral and bilateral agencies have been active in supporting environmental conservation measures in one or more of the countries covered by the programme. The main multilateral institutions are the World Bank (primarily financing of environment related investments), UNDP (building capacity and supporting the formulation of policies and strategies at the level of governments and civil society institutions) and UNEP (promoting cleaner production). Major bilateral players are GTZ (promoting environmental awareness, the establishment of norms and standards, eco-labelling and demonstrating cleaner technology options), USAID (promoting cleaner production, developing and defining opportunities for environmental investments), and DANIDA (promoting cleaner production). Of these efforts, most are multi-sectoral in nature, although GTZ has devoted specific attention to the leather industry among other sectors, and that institution's programmes are the most closely related to UNIDO's activities in the leather industry. The present UNIDO programme forms far more than a complementary initiative, as it focuses exclusively on the leather tanning and attempts to deepen the realisation of environmental protection by the industry by demonstrating, adapting and supporting the adoption of cleaner production and end of pipe treatment measures.

2.3 Relevance

2.3.1 There are four basic aspects of the programme:

Support to the environmental efficiency of the industry in participating countries by demonstrating cleaner production and effluent treatment technologies;

Support to occupational safety and health in the tanning industry;

Promotion of the participation of women in the tanning industry;

Establishing a set of internationally agreed guidelines for eco labelling in the leather industry.

2.3.2 As regards the first two aspects, observations in the field as well as the objective situation confirm the validity of the programme's objectives, as originally conceived in the project document. The attainment of a quantitatively and qualitatively improved environment performance as well as labour standards are, and will remain, an imperative on a sector which is subject to increasingly stringent national regulation and international customer standards. While regulation and control and the setting of standards is one of the necessary conditions for attaining improved environmental performance or work safety conditions, the promotion, demonstration and implementation of technologies and solutions is the other condition for actually *realising* the desired improvements. It is often forgotten that the technology of tanning is very different from the technology of treating liquid or solid wastes from tanneries, and that effluent treatment is a cost burden on the industry. For these two reasons - technological and economic - there is a great deal of validity to public support programmes, which demonstrate least cost and effective options for dealing with the problems at hand.

2.3.3 The validity of the other two aspects - women in the tanning industry and eco-labelling - cannot be unequivocally confirmed.

2.3.4 The participation of women in tanning industry is a function of a host of factors, ranging from the vastly differing labour market conditions in the countries concerned, to deep-seated social attitudes and traditions. Indeed, it is debatable whether UNIDO could and should promote the employment of women in some of the shop floor processes in this industry, which are noxious and hardly conducive to improving the quality of employment of women. It would, however, be entirely valid to support the participation of women at the entrepreneurial, management and technological levels of the tanning industry, as would be the necessity of paying attention to several issues surrounding the participation of women in the leather products industry, where gender related issues are far more prominent. Dealing with these issues would require, among other things, development of training and skill formation programmes for women, supporting improved OSH measures - something entirely out of the scope of this project and its resources.

2.3.5 It has to be mentioned that women can be and are employed to a higher extent in the finishing departments of the tanning industries, where the working conditions are much more easier than in the beamhouses and the tanyards. In addition, in Tamil Nadu one tannery is fully operated only by female personnel: the whole staff and the management consists only of women. Furthermore, it seems an outstanding experience in South India that the quality of work and working environment (housekeeping) improves in tanneries, where women are employed.

2.3.6 Finally, the question of eco-labelling drew a great deal of attention about one decade ago, and the concern was that it may pose a market entry barrier (in the worst case) or a selling point (in the best case) if it found consumer acceptance. Hence, the legitimate effort was undertaken towards establishing a set of acceptable international norms for eco-labelling for leather and leather products, in order to avert the advance of spurious claims or unrealistic product or process standards on an arbitrary basis. However, given the time elapsed since the introduction of eco-labels in the industry, it seems that eco-labels have had the minimal discernible impact on consumer preferences in the developed countries, and eco labels do not seem to have replaced the customer / purchaser standards to which developing country exporters have to conform, in any case. The question of the relevance of eco-labelling guidelines may warrant re-examination in the light of the experience in the international marketplace.

2.4 Project Design

2.4.1 Originally the programme was designed as a fairly conventional capacity building-cum-demonstration project (cf. Project Document for US/RAS/92/120 and US/RAS/92/120 Rev.1). Essentially the programme would work through public sector industry-support or regulatory bodies, developing a demonstration site at the regional level, and one or two sites each at the country level, under the aegis of these bodies. The demonstrations would be reinforced by a number of guidelines, studies, recommendations etc., which would equip counterpart institutions in multiplying / demonstrating the programme's results. As is often the case in this approach, the effectiveness and sustainability of project results depends primarily on counterpart institutions as regards their effectiveness and equations with industry. As has previously been noted the capabilities of counterpart institutions vary quite significantly among the participating countries, subjecting the original project concept to a fairly high risk as regards impact.

2.4.2 During the programme's early stages of implementation, with the setting up of the Regional Office and by the holding of the First Co-ordination and Planning Meeting (March 1996), the programme in line with actual counterpart demands extended its scope beyond the original concept both in size of the units (full industrial scale) and also in a larger number towards direct support activity as regards its environmental and OSH components. Thus, it was decided that more than several regional demonstration sites would be created, and that the scope of demonstrations would be expanded to cover several technologies for cleaner production over the entire production and waste treatment/disposal cycle. Most importantly, the demonstrations, whether of process changes or of model plants, would be implemented on a cost shared basis in the actual commercial operations of beneficiary enterprises rather than being show-cased on the test bed of one or the other public sector R&D facility. The direct support strategy had distinct advantages:

The project activities would enlist the private sector as an active partner rather than passive observer to the project activities;

Since the private sector (especially in Chennai and surroundings) had already undertaken large scale investments in effluent treatment - a result of strong national legislation and enforcement - a lot more technology options could be demonstrated as technology "add-ons", than would have been the case had the project created green field demonstration sites;

Successful demonstrations would be relatively easier to propagate as they would emanate from their introduction into actual commercial operations of the industry;

This shift in strategy seems to have found immediate receptivity in India, and is receiving acceptance in Nepal. In Indonesia the project strategy remained basically unchanged from the original conception of the relevant national project. An effluent treatment plant was created under the supervision and ownership of the counterpart R&D institution, to no positive effect thus far.

While it is easy, in retrospect, to summarise and award positive recognition to the change in the project strategy, it required the fulfilling of several assumptions and preconditions which were critical to implementing the revised approach;

The direct support-cum-demonstration strategy requires a high degree of credibility for the project, in the eyes of the beneficiary industry, especially if counterpart cash or in-kind contributions are required. Attaining credibility is an extremely time-consuming process at the initial stages, and depends on the institutions *as well as* the individuals managing

the project; UNIDO's asset was that its standing was already well established especially in the leather sector in India due to successes of previous projects;

Project demonstrations in private sector facilities require a high degree of co-operation on a realistic basis between the industry and the immediate counterpart institution, as well as among private sector participants themselves. Establishing these bases of cooperation also consumes time and effort. The simpler the basis of collaborative venture, the greater the chances of its success;

The project results, if found commercially feasible and operationally efficient, will be more robust when tested in commercial operations, however, the technical, operational and economic aspects of project demonstrations require careful monitoring and recording to sustain the credibility of results;

Finally a potential drawback of the direct assistance strategy is the prospect that results or benefits stay within the confines of individual enterprises or clusters of enterprises. While the project took this into account by concluding MoUs with beneficiary enterprises and facilities, requiring those enterprises to be open to others for purposes of training and review, this risk factor requires careful attention and the creation of effective propagation mechanisms in future phases of this project.

2.4.3 The different PDU contents were chosen during the two Co-ordination and Planning Meetings in the beginning (March and September, 1996). The selection was made mainly on the basis of the demand of the (Indian) tanners, recommendations of counterpart institutions (e.g. Chinese, Indian and Indonesian), international (CTC) and UNIDO experts. Selection was based on well defined criteria such as relevance, availability of funding, demonstration effects, openness (to visitors) of the counterpart company where the PDU was to be installed etc. However, a detailed analysis of requirements e.g. by exemplary audits or surveys was not carried out and a ranking of needs for example in accordance with generic or defined criteria (as it is suggested e.g. in ISO 14000) for ranking of environmental aspects, was not done. One reason was the lack of time for such lengthy undertakings. Another one was the urgent need for solving the difficulties of the South Indian tanneries closed down by the Supreme Court in 1996. So, PDUs resulted with an emphasis on waste and effluent treatment and disposal - focused mainly on end-of-pipe measures.

2.4.4 Thus, not all of the PDUs finally implemented fully cover the basic needs of the tanneries in the South East Asian region. And some of the PDUs are too much research oriented (e.g. UASB or RO), so the basic needs like waste reduction at the source, resulting in cost reductions, are not fully covered. Furthermore, the majority of PDUs is addressing end-of-pipe approaches (CETP, reed beds, TDS, sludge problem, etc.) more than in-process issues (e.g. "improved conventional tanning"). Thus, the approach was more end-of-pipe driven, also because of the urgent demand of the South Indian tanneries closed down by the Supreme Court in 1996. Clean technologies, which are more directed to waste abatement strategies and cost reduction, and more process oriented than fixed to final treatment and disposal of effluents and solid wastes were not so much followed as it would have been advisable from a different point of view.

2.4.5 PDUs elected from a wide variety of possible topics for pollution control measures and cleaner technology options determined on the basis of audits, surveys or similar activities are more for the company level, whereas the mandate of UNIDO to find solutions for clusters of tanneries and for common technical measures like CETP.

2.4.6 Those audits and surveys would allow to select PDUs thoroughly, sensible and meaningful - and above all according to individual needs, which are not immediately known, even by the tanners

themselves. Only those who know about the possibilities and chances of Cleaner Production and the options of clean technologies in the tanning industry can select appropriate alternatives. Clean technology options have to be custom tailored for each company according to the individual circumstances (process and product peculiarities), whereas end-of-pipe techniques can sometimes be more generic and can be implemented as ready made techniques, but mostly need to be implemented tailor made too. The difference lies in the availability of techniques: end-of-pipe treatment techniques are well-known by engineers and well-proven in practise, whereas Cleaner Production requires full knowledge of the production processes plus innovative potential and sometimes inventive cleverness.

2.4.7 But at the time of the PDU definition this knowledge was not yet distributed among the tanners in the region, it was in the hand of few planners and experts only.

2.4.8 In these aspects lies the big chance for the next phase of the project. Therefore, this issue will be one of the major recommendations in chapter 6. The PDUs or similar issues to be implemented for technology testing and demonstration should further be selected on the basis of Cleaner Production and Environmental Management principles and more addressing the direct needs of the industries on company level. Some of the programme's direct output (the technical publications of J. Buljan, G. Reich, J. Ludvik, and W. Frendrup e.g.) give an excellent overview of those possibilities (**Appendix 7**).

2.4.9 It is not intended to judge the PDUs as wrongly selected. In the contrary, the PDUs are one of the core achievements and highlights of the programme's outputs. However, it is felt that the efficiency and dissemination in future can be increased by a better selection in future, using the aspects mentioned above in the technical papers (thorough identification and systematic ranking).

3. IMPLEMENTATION

3.1 Budget and Expenditures (Ending May, 99)

All figures are given in US\$.

Table 1: US/RAS/ 92/120 - Assistance in Pollution Control for the Tanning Industry in South East Asia

Budget Line	Original Budget	Total Delivered	Balance
19-99:Project Personnel	2,407,224	2,205,434	201,790
29-00 Subcontracts	537,712	537,072	640
39-99 Training	337,291	300,618	36,673
49-99 Equipment	714,863	633,311	81,552

59-99 Miscellaneous	138,958 ¹⁹	121,190	17,768
99-99 TOTAL	4,136,048	3,797,625	338,423

Table 2: US/IND/ 97/124 - Assistance in treatment of tannery effluent in the state of Tamil Nadu, India, Phase II Tertiary treatment,, and utilisation and disposal of sludge

Budget Line	Original Budget	Total Delivered	Balance
19-99:Project Personnel	87,419	37,516	49,903
29-00 Subcontracts	75,000	74,159	841
39-99 Training	16,727	7,727	9,000
49-99 Equipment	181,265	101,393	79,872
59-99 Miscellaneous	6,589	4,133	2,456
99-99 GRAND TOTAL	367,000	224,928	142,072

Table 3: US/INS/ 92/120 - Assistance in pollution control and treatment of tannery effluent in two selected areas of Indonesia

Budget Line	Original Budget	Total Delivered	Balance
19-99:Project Personnel	136,169	89,035	47,134
29-00 Subcontracts	127,118	127,118	0
39-99 Training	25,925	22,925	3,000
49-99 Equipment	313,016	249,517	63,499
59-99 Miscellaneous	9,276	6,368	2,908

99-99 GRAND TOTAL	20 611,504	494,963	116,541
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Table 4: US/NEP/ 92/120 - Establishment of model and demonstration tannery effluent treatment facilities in Nepal

Budget Line	Original Budget	Total Delivered	Balance
19-99:Project Personnel	106,384	100,849	5,535
29-00 Subcontracts	134,000	134,000	0
39-99 Training	32,345	30,845	1,500
49-99 Equipment	327,097	323,309	3,788
59-99 Miscellaneous	17,174	12,286	1,888
99-99 GRAND TOTAL	617,000	604,289	12,711

From a recompilation of the project budgets, it can be discerned that UNIDO inputs were distributed as follows:

Table 5: Regional Project India

Project Component	Experts Number/ \$ amount	Training	Equipment
Regional Programme Office	1,241,657*	28,020	83,416
Environmental efficiency	856,312	221,801	397,931
Occupational Safety and Health			
India	31,023	5,029	56,866
Nepal	15,099	-	17,924

	China	21	18,071	6,000	54,957
	Indonesia		7,244	6,000	22,216
Women in Development					
	India		3,475	12,000	-
	Nepal		6,489	-	-
	China		18,071	5,000	-
	Indonesia		7,244	-	-
Eco-label					
	India		747	4,270	-
	Nepal		-		-
	China		-	6,000	-
	Indonesia		-	6500	-

See also APPENDIX VIII. Includes travel, administrative support (RePO and Headquarters) and Headquarters travel.

3.2 Delivery of UNIDO inputs

Table 6: Other Regional Projects

India Project:

Project Component	Experts Number/ \$ amount	Training	Equipment
Environmental efficiency	37,516	7,727	101,393

Nepal Project:

Project Component	Experts Number/ \$ amount	Training	Equipment
Environmental efficiency	92,218	30,845	297,552

Indonesia Project:

Project Component	Experts Number/ \$ amount	Training	Equipment
Environmental efficiency	84,570	22,925	249,517

3.2.1 From what can be assessed, the inputs were delivered within the overall project-planning framework, i.e. the overall time allotted to the projects. In the case of Nepal, however the construction of the additional, i.e. beyond the model envisaged in the project document, Common Effluent Treatment Plant was delayed by several months due to a delay in concluding the agreement between the three sponsoring tanneries as to the location, counterpart contributions and modus operandi of the plant. While the equipment has been delivered, that plant is expected to be operational by mid August 1999. The evaluation team saw the civil works being undertaken. Also in Nepal, the OSH demonstration was delayed due to the apparent appropriateness of the demonstration site. The site has now been agreed by the project counterpart and the demonstration site is envisaged for completion by August 1999.

3.3 Delivery of the Clients' Inputs

3.3.1 The major counterpart inputs covered cash or in-kind contributions by private sector or public sector entities to the environmental aspects of the project or to OSH demonstrations. The Tables listed in **Appendix 5** present an assessment of the value of counterpart contributions in the participating countries under the two project components. Besides the two cases cited in the previous section, there seemed to have been no major problems encountered as to the quantity, quality, or timeliness of counterpart inputs, once agreement was secured.

3.4 Activities/Use of the Inputs

3.4.1 Work plans have been elaborated, unfortunately the evaluation team did only see one set of work plans in the Chennai RePO: the ones for the different PDUs (see also **Appendix 6**). Indeed, detailed time tables for the main activities of the programme or the single projects were not presented. Nevertheless, the activities are carried out timely and as it seems in a logic sequence with respect to the planned features of the Project Documents.

3.4.2 According to the requirements of the Project Documents the different project teams in the three countries - supported by sub-contractors, consultants and other actors - were active in the following major fields:

- Planning and coordination work:

Harmonising and coordinating expectations and contributions of different groups and

stakeholders and all related performance

State of completeness: This kind of work is ongoing until the end of this phase and carried out with good success in the three countries

- Administrative work:

All kinds of required administrative work

State of completeness: Will last until end of this phase, since this work is of continuing character.

- Engineering work:

Identifying and structuring case studies

Designing and supervising construction of new ETPs/CETPs,

Assisting in planning and implementation of improvement of ETP/CETP components

Equipping laboratories and training staff

Elaborating reports

State of completeness: Four ETPs/CETPs are upgraded and operational and now serving as models in India; one ETP is newly constructed as a model in Nepal; they could be used as demonstration models for the whole Asian region. Even the plant in Indonesia has been finished, because of non-technical reasons it cannot be operated now.

- Training and information:

Preparing information material (manuals, videos, brochures, leaflets, etc.)

Conducting seminars, workshops, conferences, etc .

Guiding delegations and visitors

Setting-up an information and documentation unit at Chennai

State of completeness: The process of knowledge and know-how transfer, dissemination of technically suitable and economically viable solutions and results of PDUs has started. However, caused by the complexity and variety of options and the large size of the tanning sectors in the relevant countries, a wide spread circulation of results and technical improvements and solutions takes time and needs further efforts and input of financial means and manpower. Therefore the activities cannot yet be completed by now, nor by the end of this phase. Nevertheless, numerous training courses, seminars, workshops and seminars have been organised in India, Indonesia, Nepal and China and the number of trained persons is exceeding the figure of two thousand. They came not only from the three core countries, but also from the whole region.

- Tanning process related work:

Advice to tanners how to implement advanced and low-waste techniques, recycling methods and other technical options in form of demonstrations and tests

State of completeness: According to planning a great part of the activities has been achieved, however, many options are still not yet covered and may be in the focus of the next phase (see below).

- Waste disposal management:

Elaboration of tests and demonstrations for treatment or final disposal of hazardous wastes

State of completeness: The state of these efforts can be seen below in chapter 4, where the PDUs are described, activities have been completed up to about 70 or 80 %.

- Effective integration of women:

Collecting data, training, awareness rising among the tanners and relevant institutions

The activities have been followed according to planning; an improvement of women's employment in the proper tanning sector is difficult.

- OSH:

Data collection, conducting surveys, selecting model companies, implementing technical demonstrations and pilot units, and elaboration of a manual

State of completeness: A comparative overview, a regional and national survey report and a comprehensive OSH manual (the first one for this sector worldwide) were made - all according to planning. Several companies in India and one in Indonesia were completely transformed into model tanneries with concern to OSH and good housekeeping. In Nepal a certain delay occurred, because the selection of a suitable company willing to cooperate was difficult in the beginning. The activities there will be completed by end of this year.

- Eco-labelling:

Seminars and other activities were undertaken to inform the tanners in the three countries on the issue of eco-labelling in the leather sector. Eco-labelling is an issue, which is handled on an international more than on national level and has more to do with the requirements of customers in the developed countries - as mentioned above in chapter 2.1. UNIDO was the driving force in harmonising the worldwide eco-labelling efforts in the leather sector in the last few years, in this context the project contributed to this complex. Also, the understanding of the issues (e.g. product or process based, certification etc.) concerning eco-labelling especially in the producing countries, was greatly enhanced under the project.

3.4.3 In view of the large variety and huge complexity of the tasks performed by the RePO team members the extent to which the main activities have been completed is enormous.

3.4.4 Further aspects related to activities and input from the project teams are important:

National and international staff worked together in performing activities. A fruitful and

successful cooperation between local experts and experts from other Asian countries or Europe took place. No complaints of difficulties or drawbacks were reported to the evaluation team. This is true for all three countries.

Several technical experts, training and teaching experts from developing countries were assigned in the three countries; this is remarkable in view of the relatively new and sophisticated technical fields and with relation to TCDC.

Other parties and organisations involved in the implementation of activities like TNPCB, CLRI, etc. are the ones listed in Chapter 2.2 and local or international sub-contracting firms.

3.4.5 There were surprisingly little difficulties encountered performing the activities. The reason for this pleasing and interesting fact are the careful selection of counterparts, coupled with joint review of appropriate technological intervention as well as the readiness, which the project found in India among the tanneries to implement pollution control measures. The closure of more than 400 companies because of violation of environmental laws - a big threat for this whole industry sector - was of course a driving force for the easy acceptance of the project's proposals, at least in India. The RePO team in Chennai was following strictly the principle of maximum involvement and commitment of the industries and the associations. Moreover, the activities and topics (PDUs and technical demonstration options) were selected and structured according to the actual needs of the tanneries in Tamil Nadu.

3.4.6 In **Indonesia**, which is currently in a totally different socio-economic situation, the implementation was much more difficult than in India: the ETP, which was constructed at Gambiran, could not be set into operation. Other planned activities are still in delay.

3.4.7 In **Nepal** problems occurred with the selection of the OSH demonstration tannery and because of communication uncertainties between RePO and government organisations. The planned ETP was constructed, commissioned and operated within the time frame but the complementary CETP construction was delayed, because of tanners hesitating to start investment, but after the creation of a revolving fund the implementation could be started.

3.4.8 In both countries, Indonesia and Nepal, the enforcement of the existing laws is not as strict as in India. Although, there exists pressure from the finished leather and leather goods importing industrialised countries with regard to environmentally sound leather production for each Asian country. The situations in Indonesia and Nepal differ very much from that in India, where the tanneries are already using more advanced technologies. Moreover, the Indian tanning industry is technically more developed.

3.4.9 However, the difficult Indonesian conditions form a good chance for implementing cost reductions within the production process, which can be realised rapidly by cleaner technologies introduction. Whereas the chance to shift the tanneries to new places, where large investments have to be made for add-on end-of-pipe-techniques take more time and are more costly.

3.4.9 Other parties/organisations involved in the implementation of the activities were mainly CLRI and the sub-contractors (BLC, CTC TEH Projekt from Europe, and several local companies).

3.5 Assumptions

3.5.1 Assumptions like timely mobilisation of relevant funds and risks like major delays in Government inputs partly held true, but did not severely affect the programme realisation and the achievement of planned results and objectives not in the one nor in the other way. The availability of appropriate sites for example was not a problem.

3.5.2 Incidents and circumstances like the riots in May, 98 in Indonesia, cannot be mentioned as general risks. The main and true reasons for the setbacks in Indonesia are to be seen in the selection of the Gambiran tannery and in some technical issues, but not in the political conditions, under which the ETP had to be closed.

3.6 Project Management

3.6.1 The programme's field implementation is done by staff at the RePO led by the Programme Coordinator. The team and management at RePO in Chennai are very capable and competent. They work with very high motivation and are excellent in engineering, organisation, and administration.

3.6.2 Similar statements can be given for the national execution teams in Nepal and Indonesia; even though, these teams are much smaller and have widely differing tasks and structures. In the case of India, the RePO staff is also responsible for implementing the national project.

3.6.3 The distribution of responsibilities between RePO and the national teams is well functioning, apart from some difficulties in efficient and meaningful communication and documentation. For example: deficiencies occurred, when the Nepalese counterpart organisation (NBSM) sent the analysis reports of the ETP monitoring to Chennai. There was no reply so far, even, when some critical and contradictory data are submitted (sulphide concentration in treated effluent were higher than in raw effluent!).

3.6.4 It has to be mentioned that there is a very good cooperation between the target beneficiaries in the three countries (in particular in Tamil Nadu/India) and the programme management at RePO. Periodic meetings for review were organised. Work planning and monitoring sessions seem to be carried out. However, no documentation of other meetings besides the two Co-ordination and Planning Meetings were made available to the evaluation team.

3.6.5 Some kind of peer review on both, technical level and monitoring of planning and execution of activities seems to be a requirement (see Chapter 6 for details).

3.6.6 Backstopping by the UNIDO project management is very effective and of highest thoroughness. Nearly all inputs are scientifically outstanding and represent the state of the art of pollution control and clean technology in leather technology. There is no doubt that the team of experts at UNIDO headquarters and the external leather experts involved are representing highest expertise in this field.

4. RESULTS

4.1 Production of Outputs

4.1.1 The production of outputs is reviewed under the following subject areas:

- Support to the environmental efficiency of the industry in participating countries by demonstrating cleaner production and effluent treatment technologies;
- Support to OSH in the tanning industry;
- Promotion of the participation of women in the tanning industry;
- Establishing a set of internationally agreed guidelines for eco labelling in the leather industry.

4.1.2 The tables and overviews in **Appendix 5** provide a detailed comparison of outputs envisaged vs. outputs produced. In this section a summary overview of programme achievements is provided.

4.1.3 It was not possible to evaluate systematically and completely the *impact* on beneficiaries of the manuals, guidelines, audio visual material, workshops and seminars produced under the OSH component, the team had neither time nor resources available to review these outputs with beneficiaries. However, the positive response on these activities and a certain impact could be understood during visits to tanneries, manifold meetings and discussions with tanners and tanners' associations in the different regions visited. All in all it can be stated that the demonstrated OSH measures form a very good starting point for further improvement and OSH implementation in the majority of the Indian tanneries.

4.1.4 The review of issues related to the participation of women in the tanning industry was conducted by the project management in the three countries concerned. The amorphous nature of project counterparts (or the absence of those counterparts) made it impossible to have a beneficiary-based assessment of this aspect of the projects.

4.1.5 In Chennai and Tamil Nadu/India, which was the basis for demonstration of regional projects, circumstances at the time of project commencement were such that the tanning Industry was under considerable pressure vis-à-vis effluent treatment. As a result several tanneries or clusters had already undertaken investments in primary or secondary effluent treatment. Rather than create a possible redundant model plant, the project strategy was oriented towards demonstration of four full scale model effluent treatment plants representing different aspects of tannery effluent treatment plant in terms of influent, treatment process and size. Thus, the Ranitec CETP with treatment capacity of 4,000 m³/d receiving effluent from 76 tanneries processing from raw to finished and using amongst others an anaerobic treatment system (lagoon) was upgraded to serve as a model for similar treatment plants in the region. The Vishtec CETP with a capacity of 3,400 m³/d of effluent using two stage aerobic treatment system was upgraded (mainly process control) to be a second model site. The President Kid Leather Company ETP, 120 m³/d receiving effluent from semi-finished to finished tanning processes from an isolated was upgraded as a model site (automatic dosing, laboratory). The MHT Company ETP, capacity 100 m³/d, receiving effluent from a traditional isolated vegetable tannery, a low cost anaerobic treatment system, was upgraded and serves as a model for similar units.

4.1.6 Also, in partnership with the tanners, technical institutions and suppliers of water treatment technology, the project was able to undertake 15 PDUs to examine technology options in waste minimisation, secondary or tertiary treatment, or in final waste disposal. Details of those demonstrations, which are being undertaken mostly in commercial facilities, are presented in **Appendices 5 and 6**.

4.1.7 In addition, the technical and commercial results of the technology options were recorded and a large number of technical publications have been produced (see **Appendix 7**). This list represents

an excellent overview of the programme's overall technical and thematic output.

4.1.8 Dissemination of results was also facilitated through numerous seminars/study tours and training programmes undertaken for more than 2200 participants from at least 8 countries of the region, as well as by 15 OSH demonstration and upgradation sites among other activities.

4.1.9 From interviews conducted by the evaluation team with representatives of the industry in Chennai, the clear message was that the beneficiary industry saw the project as having assisted them in the critical area of applying and testing known technologies in a manner that was cost effective and suitable to local conditions.

4.1.10 Under the India Phase II project (US/IND/97/124) six outputs were to be achieved. Wherever possible the project used and built upon achievements made under the pilot demonstration units of the umbrella project, demonstration of OSH sites, cleaner tanning technologies and model CETPs.

4.1.11 Based on the request of the industry a tertiary treatment system was to be established at one CETP (Ambur). However, technical analysis of the CETP revealed that the plant's design and implementation was improper. It was therefore decided to implement as a special model for the region the rehabilitation of an earlier constructed CETP keeping the cost as low as possible. The rehabilitation is at an advanced stage after reaching agreement on the technical assessment and action plan and with equipment orders being placed.

4.1.12 Rehabilitation of purportedly degraded land by past discharge of untreated effluent has been implemented in Sidco CETP where more than 20,000 trees have been planted in degraded land whilst using treated tannery effluent for irrigation under strict monitoring conditions. A detailed report with action plan including soil amendment is under preparation for Ranitec and Ambur CETP both for direct industry implementation.

4.1.13 More results could be reported here, it is felt that the outline given above, is representative enough for the results achieved so far. The team visited and could inspect more facilities than described here, but it would exceed the size of this report to report all of them. Complete lists can be found in the Annexes.

4.1.14 Dissemination of results achieved is an ongoing activity of the programme through training workshops, organised visits to demonstration sites, technical reports etc.. In addition, dissemination has been subcontracted to the private sector through ILIFO.

4.1.15 In Indonesia, a model effluent treatment plant was to be set up at the premises of a tannery owned by the counterpart institution at Gambiran, a locality in Yogyakarta, and another ETP was to be improved at the premises of Budi Makmur, Yogyakarta - a medium sized tannery. The Gambiran ETP was designed by the subcontractor under the national project and was an expansion of the basic design at the earlier part of the project. Additionally cleaner tanning technologies were to be implemented at the two project locations and through the counterpart institution, IRDLAI, to be disseminated to the industry in Indonesia.

4.1.16 Equipment specification for cleaner tanning technologies and effluent treatment plant were made by the subcontractor. After completion of the civil works by the counterpart, the subcontractor drew up installation plants in March, 1996 and the ETP was installed by 6 May, 1997.

4.1.17 During the pre-trial runs and in several tests thereafter the ETP was unable to achieve its rated capacity due to the non-operation of the associated tannery, with the result that whatever

effluent was accumulated in its equalisation tank and in the biological treatment stage emitted a noxious smell found to be offensive to residents of a densely populated neighbourhood very closely surrounding the tannery/ETP complex. It was felt by the subcontractor's technical experts that full and continuous utilisation of the ETP would diffuse the smells and that the main issue was to have the plant running at its rated capacity, and under optimum operation. In order to achieve this, the Project Management, the subcontractor, the tanner's association and the counterpart agency agreed that the most viable course of action was to get the private sector directly involved in the management of the tannery and use of the facilities. To this effect A MOU was prepared by the Project Management and signed by Tanner association and the counterpart agency, but never implemented. Whilst actual implementation of this MOU was still preferred by Project Management as an interim measure, support was given to IRDLAI in procurement and repair of facilities so as to generate more effluent.

4.1.18 In this way, the tannery and ETP would be running on a continuous basis, the Gambiran tannery would be a source of revenue on account of the receipts from contract tanning undertaken and gradually, the most polluting wet end tanning could be moved from diffused sites in Yogyakarta to a centralised location which was protected by an effluent treatment plant. The agreement of the largest tannery in Yogyakarta was secured, and this enterprise agreed to have some of its tanning contracted out to IRDLAI Gambiran. All this took some time, and commercial tanning started in December 1997, reaching full capacity trial in January, 1998.

4.1.19 Unfortunately, though the ETP was commissioned by the subcontractor on 6 March 1998, limited generation of effluent and difficulties of counterpart agency, with the result that the ETP was run only sporadically, causing degradation of accumulated effluent, and further emission of noxious smells in the neighbourhood. All this came to a head by May 7 1998, amidst the brewing political turbulence in Indonesia, when residents of the neighbourhood staged a potentially violent demonstration against the IRDLAI management, threatening to destroy the tannery and the ETP on account of the social nuisance it posed. At the instructions of the UNIDO Representative, in consultation with the concerned officials of the Ministry of Industry, the ETP was shut down, cleaned and the machinery placed under covers for storage.

4.1.20 The senior officials of the Ministry of Industry and Trade, the Governor of Yogyakarta and the UNIDO Representative have frequently reviewed the option of relocating the tannery and ETP to an industrial estate away from residential areas, where land has been allocated by the provincial government. However, with the budgetary squeeze imposed by the prevailing financial crisis, the Government is unable to find resources to cover the costs of the civil works required to house the ETP/Tannery. Of the IDR 1.6 billion required to complete the civil works, the Government can only appropriate IDR 600 million were one to wait until the resources were appropriated in the next fiscal year, the relocation would be completed around December 2000. In a meeting on 12 June, the UNIDO Representative informed the Director General of the counterpart agency that the only option left in the circumstance would be for UNIDO to hand over the equipment on an 'as is' basis and leave the project in its current incomplete state. Even during this evaluation mission, the technical expert on the evaluation team suggested that certain technical adjustments could be effected on the ETP, and one could try resuming tanning cum effluent treatment options at the current site. The IRDLAI plant manager was not at all willing to try this option

4.1.21 The project in Nepal has six outputs:

- Introduction of cleaner tanning technologies through on-site demonstrations in each tannery;

- National and international training programmes and workshops;
- Organised visits to demonstration sites elsewhere;
- Technical papers;
- Case studies and so on.

4.1.22 A two-line chrome recovery system with a total capacity of 18 cum/d has been installed in one tannery in Birgunj and is operated continuously as a common system for other tanneries as well since the last two years. Local operators who have been trained under the project operate the system.

4.1.23 As per the project document one model effluent treatment plant was to be set up. This plant has been installed at the site of one larger tannery and purifies most of the effluents generated by the tanning industry in Birgunj. However, on the specific request of the Nepalese Government and the industry, one common effluent treatment plant for primary treatment has also been designed, equipment purchased etc. for a cluster of small scale tanneries. The two plants serve as models for other industries, too.

4.1.24 This development and the industry request are quite remarkable since the pollutant discharge standards have not yet been officially adopted and there is no monitoring of pollutants in waste water nor any enforcement. The other pressure, i.e. from buyers of leather in importing countries, mostly European, also does not apply here, since most of their semi-finished leather is exported to India and Pakistan.

4.1.25 The existing laboratory at NBSM has been upgraded with analytical instruments and a chemist has been trained in one of the private sector laboratories attached to a tannery effluent treatment plant in India. Independently the chemist is taking samples of the waste water as well as monitoring the chrome recovery unit and forwarding these regularly to the head office in Kathmandu and to the RePO.

4.1.26 Training of key tannery technicians has been achieved through in-service training, on-site demonstration of basic cleaner tanning technologies by an expert at each of the operational tanneries, through subcontractor services. Also several of the managers attended a two week training course at CLRI, India. An international expert in machine maintenance gave further assistance on site.

4.1.27 The increased knowledge of government and other key officials has been dealt with through inclusion in training programmes, both in Nepal and abroad, through regularly forwarding technical reports as well as visits to demonstration sites.

4.2 Achievement of the Purpose/Immediate Objective (Effectiveness)

4.2.1 The achievement of the immediate objectives and, thus, the effectiveness of the programme is high.

4.2.2 The different levels of the programme components are reflected in the 5 immediate objectives in short:

- Containment of environmental degradation;

- Significant reduction of the pollutants generated;
- Increased women's contribution;
- Improvement of OSH;
- Eco-labelling.

4.2.3 The different overviews given in the **Appendices 5 to 7** of this report show a high level of achievement in technical and non-technical constituents:

Technically feasible, ecologically effective, and economically suitable solutions have been developed, demonstrated, and/or practically introduced in the field. This is not only covered by the 15 PDUs, but also by a variety of other implementations (e.g. chrome recovery plants: more than 50 chrome recovery plants are currently in use in the leather tanning sector in India);

Results and immediate applications of those demonstrations, pilot units or technical options and direct improvements were interpreted, compiled, and reported;

The dissemination of those results, success stories, technical innovations, etc. were disseminated by publications, seminars, training courses, video films, posters, study-tours and many other tools and activities.

4.2.4 These three aspects in combination with the five immediate objectives reflect and represent the achievements of the programme. Since all of these aspects have been realised to a high extent, the effectiveness can be judged as high: Nearly 80 % of those features, which were originally planned, are achieved already or will be finished by end of this year.

4.2.5 There is clear acceptance of most of the demonstrated technologies and options and the majority of the technical improvements mainly in the ETPs, CETPs, and solid waste disposal sites as well as in OSH and in-house arrangements in the companies. This is proofed by sometimes immediate application in larger scale. Moreover, in several cases, the solutions are already diffused by replication or duplication.

4.2.6 Hence, further dissemination of results and demonstrated options is highly required. The foundation of ILIFO is crucial in this context, since an organisational body and institution is required for this purpose, this is important for sustainability.

4.2.7 If UNIDO would stop the contributions and pull back the financial technical and personnel support by completing the current activities and exhausting the balance funds expected to happen end 1999 or early 2000, the programme will be much less effective, have less sustainable results and impact, than after strengthening of the relevant capabilities of ILIFO for finalising the activities. The target beneficiaries can be reached best through an organisation like ILIFO, as soon as it gets the full confidence of the target groups.

4.2.8 There are very good contacts between the programme and other institutions (universities, chambers of commerce) and in particular the target industries. This is especially true for India, to a high extent for Nepal, and a certain extent for Indonesia.

4.3 Contribution to the Development Objective (Impact)

4.3.1 The project assists the leather industry in the selected countries of the South East Asia region to expand without causing unnecessary damage to the environment and avoiding undue economic burden to the industrial enterprises concerned. This is the development objective of the project. The project results achieved so far contribute much to this objective. The results are different for each of the three countries under review. In India much impact is directly visible by reduced pollution in the surroundings compared to the conditions existing before the programme started. In Nepal the achievements are similar, hence lower in extent, since the number of tanneries is significantly smaller.

4.3.2 The reduction of pollution generated by the tanneries can be measured e.g. in terms of BOD and COD discharged after effluent treatment and in terms of chromium after recovery. It goes parallel with the most recently (August 1998) reported growth of the Indian Leather exports since 1998. The same is valid for OSH, gender aspects, even for eco-labelling. Since the impact of disseminated applications (PDUs) can be hardly assessed, since their distribution is not so much advanced, direct impact of the facilities constructed under the programme can be seen and measured. Significant reduction of BOD; COD and other characteristics of effluents through improved ETPs/CETPs is resulting in an improvement of environmental quality around tanneries and tannery agglomerations.

4.3.3 The increasing exports of leather and leather goods from India mainly to Europe result in the conclusion that the quality of the products and - most important for this UNIDO programme - of the leather production in terms of environmental soundness has increased.

4.3.4 A reduced use of natural resources (water, chemicals, energy) has started in **India, Nepal, and Indonesia** in the tanning industry, due to the programme's efforts. There will be an increasing impact in **Nepal** when the project's activities will be as successful as they were in the last months, since there is a high acceptance of the project's demonstrations and implementations among the Nepalese tanners.

4.3.5 In **Indonesia**, the programme's impact still is small according to the given circumstances and obstacles, but as mentioned earlier, the cost reduction effects of Cleaner Production, if followed more stringently will be effective and lead to an impact increase in the near future.

4.4 Sustainability

4.4.1 It lies in the nature of end-of-pipe pollution control measures that in places, where law enforcement is weak and customer requirements are not very stringent (e.g. where export to industrialised countries is low like Nepal and Indonesia) the effectiveness of waste water treatment and proper solid waste treatment and disposal are low and inappropriate. However, Cleaner Production does not replace end-of-pipe techniques, but it reduces the expenditures for end-of-pipe techniques. If fewer pollutants are discharged to the ETP, it can be smaller (lower investment) and operated cheaper (lower operational costs). Consequently the implementation of Cleaner Production in combination with improved end-of-pipe techniques is the optimum solution.

4.4.2 End-of-pipe measures are add-on measures, which cause additional costs for the companies. Cleaner Production measures or waste minimisation (reduction of pollution by abatement and replacement, recycling and reuse) mostly lead to direct cost reduction and result in immediate technical and economic advantages for the companies.

4.4.3 In the case of this regional programme and the national projects, Cleaner Production

combined with good housekeeping implementation and OSH also as tools for cost reduction and opening up of new markets would be a very good instrument for improving and realising sustainability.

5. CONCLUSIONS

5.1 The various measures and activities undertaken in the framework of the programme (PDUs and all other activities) addressed the urgent problems faced by the industry in the region, at the time the programme was launched. Hence, their relevance and utility have been recognised by the industry. Most PDUs and demonstration activities are concluded soon, so dissemination of results and success stories or replication in India and other countries is much required. OSH issues are demonstrated and need to be consolidated and further diffused. Clean technologies and end-of-pipe measures form a holistic approach as it is needed to meeting present and future market and customer requirements and national legal demands.

5.2 The launching of the programme was timely. It has been acknowledged in all the countries where the programme has been implemented. In particular in India, where the Supreme Court closed down more than 400 tanneries in Tamil Nadu, because of violation of the environmental laws, the activities in the field of pollution control, ETP and waste management were highly welcomed by the tanners and their associations.

5.3 Demonstration sites relating to OSH improvements and cleaner techniques are all in operating tanneries and therefore well chosen. Visits to such sites by other tanners from the region create direct impact. Thus, the awareness of tanners to make self-audits and assessment of their requirements in respect of cleaner technologies, environmental management, and OSH related matters has been enhanced. Further efforts towards wider diffusion of important achievements under the programme will help the tanning industry in the region.

5.4 Increased awareness relating to environment and OSH related matters is a clearly visible effect in all countries. This is more pronounced in India where customer and market requirements are greater. In all countries the preparedness of tanners in these respects has been notably enhanced.

5.5 Though the PDUs implemented are indeed relevant to the urgent needs of the industry, these are more oriented towards end-of-pipe treatment rather than adjusted to process and aligned to pollution generation within production. Proper ranking of the problems, on well-defined criteria, will have further enhanced the value of some of the outputs. Few PDU topics were too much research oriented and, thus, not of large relevance for the tanning industries, in particular for the SMEs.

5.6 Chrome management in tanneries has been given due importance. However, presence of chromium in solid wastes and sludge could have been given more adequate relevance during final disposal. The hazardous potential of chromium (in its trivalent stage) still has to be fully recognised.

5.7 The technical information generated by the programme has been found to be of very high quality. These have been started disseminating through seminars, workshops and training organised for the region as a whole as well as in participating countries. The programme has been successful in propagating cleaner technologies as well as the much-required end-of-pipe measures, with the result that the regional partners in Indonesia and Nepal gained much advantage and improvement from the activities and support of the national project in India as well. Many programme activities, particularly relating to demonstration of cleaner technologies and end-of-pipe treatment

technologies, were mainly concentrated in Tamil Nadu, South India.

5.8 The immense number of reports, publications and other papers and information material, and their authors as partly listed in this report in combination with the PDUs carried out and under implementation (see **Appendices 5, 6, and 7**) lead to the following conclusions¹

Transfer technology implemented under this programme include the very significant elements of technology upgrading and adaptation;

The project not only absorbed professional inputs to produce the planned outputs in the field, but, as a by-product, it also processed and documented the experiences and the advances achieved in technology application and, thus, contributed to the stock of knowledge in this sector.

5.9 The objective of enhancing employment of women in the tanning sector did not achieve significant visible success. This is due to the difficult work environment in tanneries, various social inhibitions about women being employed in industries, labour market situation in different countries and a general aversion of women to employment in special sections of tanneries. Possibly for the first time in India women development in the leather sector was comprehensively addressed. However, with improving work environment in tanneries with the introduction of improved OSH measures, the situation will change in the future. Downstream industries like shoe factories in all countries are employing mainly women.

5.10 On the objective of promoting an eco-label for leather and leather products, the activities undertaken under the project towards harmonisation of different country approaches are steps in the right direction. The issues and concepts (product - process based, certification, etc.) were explained and the understanding has improved. However, at the present juncture, no immediate efforts appear warranted due to the uncertain value of such eco-labels in the global market on the one hand and the presence of labels (or more general: requirements) promoted by private enterprises on the other.

5.11 In Indonesia the implementation of OSH measures and selected cleaner technology options for demonstration was successfully finalised. An ETP was constructed, but not put into operation.

5.12 In Birgunj in Nepal a series of tanneries uses a CRP commonly and regularly, an ETP was set-up recently and is in operation in one tannery; it will function as a demonstration unit for other companies. Moreover, a CETP will be completed by the end of this year. The delay in OSH implementations will not have a negative effect on the programme's overall success, since all the measures in the field of abatement and pollution control enjoy a high acceptance by the Nepalese tanners.

¹ The team was by no means able to see all or only a significant number of these numerous documents; however those few reports including one video tape, which could be studied in their majority were of professional excellency and are very much suitable to be used for dissemination and improvement of the whole sector not only in the region of the project it must be assumed that the rest is of similar quality.

6. RECOMMENDATIONS

6.1 The programme is judged as a success. It has implemented pollution control measures and in-house improvements in leather tanneries and their agglomerations, the most important industrial sectors in the region, through a suitable and comprehensive approach. This approach is characterised by doing the right things at the right time (improvement of effluent treatment plants) and creates *know-how* through *show-how* (Pilot and Demonstration Units). The technical performance and work quality including the management are evaluated as excellent. In some aspects the achievements of the programme even exceed the original planning.

6.2 To realise and achieve the recommendations outlined below realistically, it is recommended that the programme should carry on its activities, at least, for three more years. The programme should immediately prepare a successor phase document, based on the conclusions and recommendations made in this report. The focus, as brought out in this report, must be on consolidation, replication, diffusion, and assured sustainability.

6.3 The programme should pursue the following principles:

Avoid generation of wastes at source;

Reuse wastes and by-products as far as possible;

Further improve effluent treatment;

Dispose of inevitable wastes properly;

and therefore focus on:

Continuation of still incomplete activities;

Dissemination of achieved results and demonstrated techniques;

Cleaner Production and systematic Environmental Management introduction.

6.4 It is foreseen that all PDUs will be completed by the end of this programme phase. Such of these as would qualify for replication will need to be replicated within India as well as in other countries of the region. This is an important activity, which the programme must take up and complete to help the industry derive the full benefit of these achievements in the entire region. There is an immediate need to consolidate all viable achievements under the programme, be these relating to cleaner technologies, end-of-pipe treatment, or OSH improvements. This will involve proper documentation of these achievements in the form of simple, easy to assimilate technology packages, videos, and interactive CD ROMs such that this vital information will be accessible to tanners in South East Asia and from any part of the world.

6.5 Cleaner technologies, with accent on improving productivity and quality of leather in tanneries and end-of-pipe measures should combine to form a complete holistic approach. Such an approach will find wider acceptability and is appropriate for meeting present and future market and legal requirements. The emphasis should shift more towards cleaner technologies now that the urgent problems relating to end-of-pipe treatment have been dealt with. In this regard laying greater

emphasis on simple and inexpensive improvements thereby providing immediate cost benefits to the companies will help to build confidence. This will make it easier to proceed to essential but large and long-term investments.

6.6 Future needs of the industry must be identified in a systematic manner, prioritising the needs carefully with due consideration to present and future market requirements, legal and social needs, and industry's own capability. The programme should promote introduction of Environmental Management Systems (EMS) as a tool for reduction of cost of production and improvement of quality.

6.7 The programme may, where the situation calls for, provide training and information diffusion for private consulting companies in areas of cleaner technologies as these carry greater chances of sustainability. End-of-pipe treatment technologies should still be recognised.

6.8 The programme should continue working directly with interested individual companies as it did before. Demonstration of technical applications and improvements in real dimensions and under conditions of direct use in the processes is the best way to convince the industrialists in this sector to use new cost saving and cleaner technologies. Those demonstrations can easily be placed at and implemented with cost sharing and under the condition that the company allows others to visit and study the plants, techniques or whatever has been implemented. This too will ensure sustainability of projects and facilitate easy handing over of the activities of the programme at its conclusion. More emphasis should be put on simple and inexpensive improvements (such as the PDU "improved conventional tanning", which was very successful) providing immediate cost benefits to the tanneries. This builds confidence and eases large and long-term investments.

6.9 In a fast changing global environment, particularly with regard to cleaner and environment management technologies, a programme like this should provide regular and continuous review by one or two independent specialists, at least once a year (peer review). It was noted that the programme has been getting expert advice for its different projects from international and national consultants but an independent expert review at the end of each year may be beneficial to the programme.

6.10 The toxic potential of chromium should not be underestimated. Uncontrolled dispersion of this heavy metal in soil and water may lead to severe contamination of ground water and finally drinking water resources. Adequate caution must be exercised when chrome-containing sludge is utilised in any form or disposed of in a safe disposal site. As soon as chromium is discharged in form of pre-treated effluents or by leaching solid wastes it reaches the ground water tables and drinking water resources and is within the nutrition chain.

6.11 As energy is an important component of cost of operation of ETP/CETPs, specific attention towards promoting energy audits in these plants and helping them conserve energy is recommended. The same is true for the companies themselves.

6.12 The sustainability of ETP/CETPs will directly depend on the efficiency of enforcement mechanisms, global market requirements, and societal pressures. These factors vary from country to country. In countries like India where these are pronounced, the sustainability of ETP/CETPs is virtually ensured. However, where these factors are absent or weak, such as in Nepal or Indonesia, the sustainability will have to depend entirely on the positive attitude of the beneficiary. Counterpart government agencies must take note of this and initiate necessary steps to ensure that the facilities created are fully operated.

6.13 Overall sustainability of the key outputs of the programme is an important issue. Tanners of

India have taken the initiative to create an organisation, Indian Leather Industry Foundation (ILIFO) which is designed to take over the programme activities after its conclusion. Though the capital base of the organisation has been reported to be about INR 2.5 million, this organisation will require adequate strengthening before it can take over the responsibilities from the regional programme. A clear-cut strategy and plan of action must be drawn up and the programme should provide necessary support system to ILIFO in this regard.

6.14 The credibility of the programme in all the participating countries has been found to be of a high order. In all the countries visited by the evaluation team, the industry as well as counterpart government organisations specifically requested continuation of the programme for three more years to enable these countries to overcome their problems. The programme may use this credibility factor to advise the concerned enforcement agencies and environment management departments of the government on appropriate measures to improve overall environment management in the industry.

6.15 Tanneries in **Indonesia** - both, in Yogyakarta and Jakarta - are planning on request of the government to move their factories to two new industrial estates outside the cities: A real estate for about 20 tanneries, a leather technology institute, workshops and supplier companies has already been purchased by the association in Jakarta. And in Yogyakarta a plot is selected, but not yet procured, which will house 10 to 15 tanneries together with IRDLAI facilities. The building of those new tannery clusters is a very good opportunity to plan and construct modern tanneries ("Clean Tanneries"), allowing the application of cleaner technologies, efficient installations, advanced process technologies and arrangements combined with sensible and rational pollution control facilities:

Individually on company basis (e.g. recycling facilities, sewerage systems, pre-treatment installations, etc.);

Commonly used facilities on shared basis (CETP, CRP, etc.).

Moreover, downstream industries for the processing of by-products like fleshings (for glue and gelatine manufacture), chrome shavings (for leather board production) or hair (for different uses) among others can be promoted to establish too. New clusters may be joined by supplier companies (for chemicals, machinery, etc.), workshops and by institutes for technology development, vocational training or so. Another recommendation for Indonesia would be to check, if the Gambiran EPT equipment can be shifted at least partly to Garut.

6.16 The programme should consider to extent activities (diffusion of results, advisory assistance for implementation of CEPT, CRP, Cleaner Production, etc.) to the following countries in the region, whereby already established National Cleaner Production Centres would be useful tools:

Thailand (situation in the leather sector is changing in comparison to some years ago; tanners are starting to open their doors for pollution control and clean technologies, even for EMS);

Vietnam, Laos, Cambodia (leather sectors in Laos and Cambodia are closely linked to Thailand);

Pakistan (leather sector similar to India, focused on garment production, similar tanning process traditions);

Bangladesh;

Philippines;

Sri Lanka.

6.17 It should be considered to create and promote partnerships between bigger tanneries and smaller ones in the same cluster or in close locations (see e.g. experience of World Bank in Mexico²). Furthermore, many small tanneries are already working as so-called job-tanners for big ones. The newly created Cluster Development Programme of UNIDO in New Delhi may assist with ideas and experience.

6.18 It may be considered to promote or support a common dry finishing plant in **Nepal**, which should be privately operated. A plant like this would provide much required facilities for the Nepalese tanneries especially in the two regions where more tanneries are concentrated.

6.19 Communication between RePO on the one hand, and the Nepalese project office and the government counterpart organisations in Kathmandu on the other should be improved with regard to mutual information, documentation, and reaction on analytical results sent to RePO in Chennai.

7. LESSONS LEARNED

7.1 One crucial factor for the success of a major programme like this is the quality of personnel manning it. Accordingly, the choice of personnel, in this case, the team at the UNIDO headquarters and in the Regional Programme Office, is of vital importance. One reason for the success of this programme has been found to be the high quality, experience, and motivation of all members of the team.

7.2 The extent of involvement of counterpart government agencies in the implementation of the programme is critical. If the government agencies do not provide necessary support, good outputs delivered timely, may not be sustainable. In the case of India, the programme has received excellent support from the government counterpart, Tamil Nadu Pollution Control Board and the effect is quite visible in the wider adoption of technologies by the industry.

7.3 Preparedness of the industry to accept and assimilate technologies is another important factor. The current level of technology in the industry, the environment regulations in the country, the general environment management system in the country, the financial capability of the industry, the technical competence of the personnel in the industry - all these influence the preparedness of the industry. Where these factors are favourable, the acceptance and assimilation of the technologies by the industry are more pronounced. Siting the new technologies in operational tanneries has proved to be much better than putting up such demonstration units in R&D bodies. Whereby the right choice of private sector counterparts is critical to the success of the outputs and their sustainability.

7.4 “Show-how” has been a good strategy. Be these clean or end-of-pipe technologies or OSH related issues, the programme has adopted the strategy of “know-how” through “show-how”. This has been an effective means of communicating the right lessons to the industry at large.

7.5 Prioritisation of issues and solutions is essential to enhancing the value of the programme.

² The World Bank: Mexico Department and the Environmentally and Sustainable Development Sector Management Unit, Latin America and the Caribbean Regional Office, No. 18071-ME, September 8, 1998; “Mexico: The Guadalajara Environmental Management Pilot”

Though this programme has responded to the urgent needs of the industry quite well. However, prioritisation of issues and solutions on defined criteria could have further enhanced its value. In this context another lesson learned is the application and demonstration of both, end-of-pipe techniques as solutions to urgent pollution control problems as well as in-plant settlements (cleaner technologies) and new strategies (cleaner production) as long-term options, which require more time, hence less investment. For higher sustainability implementations of pollution control measures under Cleaner Production strategies using e.g. Environmental Management Systems (EMS) according to ISO 14000 or similar as starting point is highly recommendable.

The project activities would enlist the private sector as an active partner than passive observer to the project activities;

Since the private sector (especially in Chennai and surroundings) had already undertaken large-scale investments in effluent treatment - a result of strong national legislation and enforcement - a lot more technology options could be demonstrated as technology “add-ons”, than would have been the case had the project created green field demonstration sites;

Successful demonstrations would be relatively easier to propagate as they would emanate from their introduction into actual commercial operations of the industry;

While it is easy, in retrospect, to summarise and award positive recognition to the change in the project strategy, the shift in strategy required the fulfilling of several assumptions and preconditions which were critical to implementing the revised approach;

The technical support-cum-demonstration strategy requires a high degree of credibility for the project, in the eyes of the beneficiary industry, especially if counterpart cash or in-kind contributions are required. Attaining credibility is an extremely time-consuming process at the initial stages, and depends on the institutions *as well as* the individuals managing the project;

Project demonstrations in private sector facilities require a high degree of co-operation on a realistic basis between the industry and the immediate counterpart institution, as well as among private sector participants themselves. Establishing these bases of cooperation also consumes time and effort. The simpler the basis of collaborative venture, the greater the chances of its success;

The project results, if found commercially feasible and operationally efficient, will be more robust when tested in commercial operations, however, the technical, operational and economic aspects of project demonstrations require careful monitoring and recording to sustain the credibility of results;

Finally a potential drawback of the direct assistance strategy is the prospect that results or benefits stay within the confines of individual enterprises or clusters of enterprises. While the project took this into account by concluding MoUs with beneficiary enterprises and facilities, requiring those enterprises to be open to others for purposes of training and review, this risk factor requires careful attention and the creation of effective propagation mechanisms in future phases of this project.

APPENDIX I. Terms of Reference

IN-DEPTH EVALUATION

Assistance in Pollution Control in the Tanning Industry in Southeast Asia US/RAS/92/120

TERMS OF REFERENCE

B. THE IN-DEPTH EVALUATION

B.1 Purpose, scope and method

B.1.1 Purpose

The purpose of this in-depth evaluation is to enable Government bodies, UNIDO, the donors and the counterpart industrial organisations to take decisions on any changes in the final stage of programme implementation and on the continuation of the programme as well as to learn lessons from experience for planning new programmes.

The evaluation is conducted in compliance with UNIDO policy of mandatory evaluation of large technical cooperation projects and is foreseen in the project document.

B.1.2 Scope

In-depth evaluation is an activity in the project and programme cycle which attempts to determine as systematically and objectively as possible the relevance, efficiency, effectiveness, impact and sustainability of the project. The evaluation will assess the achievements of the project against its objectives, including a re-examination of the objectives and the project design. It will also assess to what degree the assumptions / risks as identified in the project document held true / occurred and identify other factors that have facilitated or impeded the achievement of the objectives. It will also review whether the approaches utilised by the project have led or will lead to optimum results or whether other approaches could produce better results.

While a thorough review of the past is in itself very important, the in-depth evaluation is expected to lead to recommendations and lessons learned for the future.

The in-depth evaluation will take into account the gradual development of the umbrella project and its funding. Within this context it will address the following specific issues:

- Changes in the socio-economic and sectoral development and the needs of the clients and target beneficiaries since the time the project was approved
- Validity (relevance) of the modified project concept and strategy, taking into account the changes and developments that took place since the project was designed (June 1991), approved in-house (July 1992), and actually started. In particular the evaluation will :
 - assess the concept of having more than 10 pilot demonstration units at an industrial scale covering cleaner tanning technologies, solid waste conversion and tannery effluent treatment instead of having one fully operational pilot

plant and other more conventional types of technical assistance (as agreed during the First Coordination and Planning Meeting, Madras India in March, 1996).

- assess the cost-effectiveness of model (common) effluent treatment plants as tools for application, training and demonstration purposes (relates to Output 1.1, 1.2 and 2.3.)
- assess the cost-effectiveness of demonstration tanneries as tools for application, training and demonstration purposes (relates to Output 2.1 and 2.2.)
- Relation with other development cooperation programmes in the sector (complementarity, duplication)
- Relation with other on-going UNIDO programmes/projects, if applicable
- Assessment of other aspects of project design, such as internal logic (outputs, activities and inputs are clear, logical and commensurate, given the time and resources available), use of indicators, focus on capacity building, inclusion of demonstration activities, etc.
- Programme management; division of responsibilities between UNIDO and national/regional authorities, clear understanding of the roles; elaboration and use of a work plan; use of review meetings of stakeholders as a management tool; technical support by UNIDO
- Delivery of inputs (expertise, training, equipment, premises, etc.) by UNIDO and the clients; their quantity, quality and timeliness; balance among inputs
- Comparison of the activities that have thus far been implemented with the work plan
- Role of the Regional Programme Office, NPD offices and the respective tannery associations in dissemination of the results in the countries concerned
- Production of outputs (how well they have been/produced as well as their significance for the country)
- As part of the above-mentioned tasks, the evaluation team should especially:
 - Review the extent to which the equipment provided meets the needs of the project and whether they are being properly utilised.
 - Review the arrangements for sub-contracts and the possible extent to which they are likely to provide the expected outputs and their cost effectiveness.
 - Review the possibilities for better integration of the private sector into the project
 - Achievement of project objectives (purpose) in terms of:
 - * capacity building
 - * demonstration effect
- Achievement (likelihood of achievement) of actual changes in the sector (impact)
- Internal factors which may or have influenced the projects' objective achievement or

non-achievement. For example, factors could include project design, quality of expertise provided, adequacy of training, etc.

- External factors which may or have influenced the projects' objective achievement or non-achievement. For example, factors could include unexpected changes in government priorities, changed economic conditions, or new developments in technology.

The evaluation team is expected to set further specific recommendations to the project management with the view of optimising implementation activities and attaining the original and/or modified targets during the remaining project life.

The evaluation team should record any significant lessons that can be drawn from the experience of the project and its results, in particular anything that worked well and that can be applied to other projects and anything that worked badly and should be avoided in the future.

The following projects are included in the evaluation: US/RAS/92/120, US/INS/92/120, US/NEP/92/120, US/IND/97/124 and (documentation of) US/RAS/97/137 (Bangladesh). An in-depth evaluation has already been conducted for US/CPR/92/120 and thus need not be included.

The field mission will visit Indonesia, Nepal, India. The recommended itinerary is attached as Appendix 1.

B.1.3 Method

Review at home base, UNIDO HQs and the Regional Programme Office (RePO) in Madras, India all documentation related to the project;

Briefing by the Office of Internal Oversight (evaluation) in Vienna;

Interview UNIDO staff at the UNIDO Headquarters and in the field office (Regional Programme Office, Madras, India);

Interview project stakeholders in the field, in particular, the target beneficiaries;

Visit the various project sites and make a detailed study and assessment of the appropriateness of the pilot demonstration units, interview the designers, users and operators of the units on the spot on its appropriateness, suitability, operational efficiency etc. and the management either on the spot or in a separately organised workshop / meeting;

Visit specialised institutions and organisations, which have been, assisted under the project, such as NLITA and NBSM (Birgunj, Nepal), ILIFO, AISHTMA and CLRI (Madras, India), APKI and IRDLAI (Yogyakarta, Indonesia).

Formulate the main findings, conclusions and recommendation and present these firstly in the field at a workshop of all stakeholders, including industry representatives and, after modification, if so required, at UNIDO HQs.

Review comments on the draft report and incorporate them in the report before its finalisation;

Although the mission should feel free to discuss with the authorities concerned all matters relevant to its assignment, it is not authorised to make any commitment on behalf of UNIDO or a donor.

B.2 Composition of the evaluation team

One external consultant in tannery pollution control and abatement

One UNIDO staff member

One national consultant (in India only).

Representatives of donor countries will be invited to join the evaluation team at their cost.

B.3 Report of the mission:

The evaluation report should follow a standard structure. In order to ensure that the report considers the views of the parties concerned and is properly understood and followed up by them it is required that:

The main conclusions and recommendations are presented to and discussed with the development partners in the field and specifically with the Regional Programme Office of UNIDO, Madras.

The main conclusions and recommendations are presented to and discussed with the Team Leader/ Project Manager, other staff concerned with the programme or project and the representatives of donor(s) at a meeting to be organised at UNIDO HQs after the mission. The draft report is submitted to the Project Manager for comments prior to its finalisation.

As the report is the product of an independent team acting in their personal capacities, it is up to that team to make use of comments made by the parties involved and to reflect them in the final report. However, the evaluation team is responsible for reflecting any factual errors brought to their attention prior to the finalisation of the report.

The final report is to be submitted in 3 hard copies and the full text on a diskette (in WordPerfect or Word) to the Office of Internal Oversight (evaluation) by 15 August, 1999 at the latest.

APPENDIX II. Mission Schedules

PROGRAMME OF THE IN-DEPTH EVALUATION TEAM

DATE / DAY	TIME (Hrs)	ACTIVITY
15.06.99 Tuesday	2150	Arrival Chennai
16 June, 99 Wednesday	1000 - 1500	Arrive RePO, UNIDO, Chennai Presentation by Programme Coordinator and his team Discussion Review of programme drawn for the team
17 June, 99 Thursday	1530 1030 - 1530	Call on Chairman, TNPCB, Chennai Visit Presidency Kid Leather (PKL) Model Effluent Treatment Plant(ETP) PDU/1 - Reedbeds PDU/9 -Irrigation trial with tannery waste water Sludge Drying Beds Occupational Safety and Health (OSH) improvements & Discussion with tannery management
18 June, 99 Thursday	1700 1000 1200 1400 1600	Departure for Kathmandu via Delhi Flight Delhi-Kathmandu Arrival Kathmandu; pick-up by Mr. Arjun K. Upadhyia (UNIDO Natl. Director) Meeting at Ministry of Industry, Mr Kalyan Pradhan, NPD; short briefing on national project Meeting at UN House: UNIDO Office Briefing by Mr. Arjun K. Upadhyia and discussions on regional project activities
19 June, 99 Friday	Mor- ning 1330	Internal discussions among evaluation team Flight Kathmandu- Simara (Birgunj) Visit to Narayani Leather Manufacturing Industries at Prabanipur near Birgunj; CRP, ETP and production lines; discussions with Birgunj tanners
20 June, 99 Saturday	2000 Mor- ning	Hotel in Birgunj: Meeting with NLITA members ,UNIDO Nepalese experts, and NBSM representative; discussion of project achievements and further continuation Internal discussions: evaluation team and Mr Arjun K Upadhyia Visit to Marium Leather Industries company in Birgunj
21 June, 99 Sunday	1000 1100 1200 1500 2000 0900 1300	Visit to Standard Tanning Industries company in Birgunj Visit to Everest Leather Industries, Birgunj; CETP under construction Flight Simara/Birgunj ? Kathmandu Dinner discussions with NPD, NBSM, UNIDO, and UNDP representatives Evaluation team: Internal discussions Meeting at the Ministry of Finance: Short visit to Special Secretary and discussion of project
22 June, 99 Tuesday	1400 1900 1000 1100 1300 1600 2140	Wrap-up meeting with NPD and NBSM representative at Ministry of Industry Flight Kathmandu-New Delhi Meeting at UNDP, Delhi Meeting with Mr. M Gulati, - Cluster Development Programme UNIDO Luncheon Meeting with Dr. D. Kebschull, IGEP -GTZ Flight New Delhi -Chennai Arrival Chennai
23 June, 99 Wednesday	1000 - 1200	Visit OSH Site GGN Visit Arafath Leathers - Chrome recovery and reuse unit

	1500	Central Leather Research Institute (CLRI), Chennai PDU/3 - Application of fleshing in UASB reactor CLRI role in RePO
24 June, 99 Thursday	0800 - 0930	Departure Chennai Visit to Prakash Feed Mills - a factory which manufactures protein from raw hide trimmings and fleshings
	1030	Arrival Ranipet
	Fore noon	Common Effluent Treatment Plant (CETP) - Ranitec, Ranipet Model CETP PDU/7- Landfill for sludge disposal PDU/9 -Irrigation trials with tannery waste water Visit to KH Shoes Common Effluent Treatment Plant (CETP) - Vishtec, Ranipet PDU/4 - Biome thanation of fleshing and sludge PDU/7 - Landfill for sludge disposal PDU/8 - Composting of sludge PDU/9 - Irrigation trials with tannery waste water ATH, Melvisharam, Ranipet PDU/2A - Reverse Osmosis
	1300	Interaction with tanners followed by Lunch
	After Noon	Common Effluent Treatment Plant - SIDCO, Ranipet PDU/7- Landfill for sludge disposal ⌚ PDU/8 - Composting of sludge ⌚ PDU/9 - Irrigation trials with tannery waste water ⌚ Output 3 - Rehabilitation of purportedly degraded land Visit to MAKH Tannery
25 June, 99 Friday	0900 - 1230	Departure Ranipet arrival Ambur-Night halt Shafeeq Shameel & Co PDU/12 - Improved conventional chrome tanning PDU/16 - Accelerated performance of solar evaporation pans Output 1 - Low Waste Environmentally acceptable leather finishing technologies Common Effluent Treatment Plant - Amburtec, Ambur Output 2 - Rehabilitation of Ambur CETP Output 3 - Rehabilitation of purportedly degraded land
	1500	Common Effluent Treatment Plant, Vaniyambadi Output 4 - Anaerobic digestion of sludge to reduce volume of sludge and improve dewatering H.Mohammed Osman & Co, Vaniyambadi OSH Departure Vaniyambadi Arrival Chennai
26 June,99 Saturday	1430	Discussion in Hotel GRT Grand Days, Chennai between members of the IDE team and RePO staff Departure of S.A. Hasnain
27 June, 99 Sunday		Preparation of Report and Presentations; discussions with RePO staff members
28 June, 99 Monday	1000 1200 1400	Visit PTIETC, Pallavaram, Chennai Visit OSH Cell ? Sri Ramachandra Medical Centre & Research Institute Review and discussion at RePO, Chennai
29 June, 99 Tuesday	0900 1100	Preparation of presentation slides Interactive workshop with members of All India Skin & Hide Tanners and Merchants Association (AISHTMA), Chennai & Indian Leather Industry Foundation (ILIFO), Chennai, representatives of relevant government departments and other agencies

		Discussion with Mr. J. Hannak, CLRI on OSH perspectives
30 June, 99	1500	
Wednesday	Morning	Finalisation of recommendations and discussions
	1400	Wrap-up lunch with RePO team
	1500	Final discussions at RePO with RePO staff members
1 July, 99	0145	Departure J. Porst for Vienna; flight Chennai-Frankfurt;
Thursday	0800	Arrival Frankfurt; flight Frankfurt Vienna
		Meeting with Mr. J. Buljan and Mr. J. Navratil at Vienna
2 July, 99	Morning	Presentation of findings and recommendations of In-depth Evaluation by J. Porst at UNIDO HQs Vienna (meeting with donor country representatives and members of the UNIDO Leather Panel);
Friday	Afternoon	discussions with Mr. J. Navratil, Mr. J. Buljan and Mr. V. Post
2 July, 99		Departure for Nuremberg, Germany
Saturday		

APPENDIX III. List of Interlocutors

APPENDIX 3.1

Persons supporting the evaluation team

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Mr. A. Sahasranaman, Programme Co-ordinator, UNIDO Regional Programme for Pollution Control in South East Asia (RePO);

Mr. K.V. Emmanuel, National Expert, RePO;

Mr. Solomon Sampath Kumar, National Experts, RePO;

Dr. Jürgen Hannak, former UNIDO international expert on OSH, RePO

Ms. Mythili Narayan, Consultant, Swiss Agency for Development Cooperation, representing the donor agency.

Ms. Srividhya Srivatsan, Project Secretary, RePO.

In Yogyakarta, Indonesia:

Dr. Rosediana Suharto, Head, Bureau for Research and Development, Ministry of Industry and Trade;

Ms. Suliestiyah Wrd. National Expert for US/INS/92/120, IRDLAI;

Mr. Ignatius Sunaryo, Chief, Tannery Waste Improvement, Use and Treatment Laboratory, IRDLAI;

Mr. Hassan Basalamah, Gambiran Tannery Manager, IRDLAI.

Mr. Drs. Benny Koeswanto, Director, CV Sapta Tunggal Leather Tannery

In Kathmandu, Nepal:

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Mr. Sanjib K. Parajuli, National Expert, US/NEP/92/120;

Mr. Kalyan B. Pradhan, Joint Secretary (TECH) Ministry of Industry, Government of Nepal, National Project Director, US/NEP/92/120;

Mr. Poorna P. Manandhar, Director General, Nepal Bureau of Standards and Metrology.

In Vienna, Austria UNIDO Headquarters:

Mr. Jakov Buljan, Senior Industrial Development Officer, Programme Manager;

Mr. Valentin Post, Consultant and former RePO team member;

Mr. Jaroslav Navratil, Evaluation Unit

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APPENDIX IV.**List of National Institutions****In India:**

- Tamil Nadu Pollution Control Board - immediate counterpart institution and host to the RePO office);
- c. Central Leather Research Institute CLRI - associated source of expertise;

All India Skin & Hides, Tanners and Merchants Association (AISHTMA) and the Indian Leather Industry Foundation (ILIFO) - Industry Associations (NB. The latter was founded and funded by the industry to be the main counterpart of the Regional Programme in India);

In Indonesia:

Research Institute for Plastics, Rubber and Leather Industry (IRDLAI), Ministry of Industry and Trade - counterpart institution;

Indonesian Association of Tanners (APKI) - Industry Association;

Agency for Environmental Impact Assessment (BAPEDAL), Ministry of Environment - Associated agency.

In Nepal:

Ministry of Industry, Technology Directorate - direct counterpart institution;

Nepal Bureau of Standards and Metrology

Nepal Leather Industry and Trade Association (NLITA)

APPENDIX V.

Outputs Planned/Outputs Achieved; Counterpart Contributions

The following tables were prepared by RePO staff Chennai.

Counterpart activities and costs for PDUs / Model (C)ETPs

V.1. PDUs

#	PDU	Counter part	Status of project	Counterpart activity	Approximate cost (Rs.)	UNIDO activity	Approximate cost (USD)
1.	1 - Reed bed	PKL	Operational for 10 months, monitoring continues, feeding increase to continue till Dec, 99.	Providing land for the construction of the tanks, assistance in operation, maintenance and monitoring	210,000	Design, construction of plant scale reed bed including civil, electromechanical components and operation & monitoring	108,740
2.	-do-	Ranitec	Operational for 10 months, data consolidated, relatively bigger plant under construction.	Complete construction, operation, maintenance & monitoring of small reed bed	40,000	Guidance in construction, assistance in monitoring	
3.	-do-	Sidco	Operational for 11 months, experiments as tertiary treatment completed, data consolidated, experiments with semi treated effluent to start June, 99.	Complete re-construction, operation, maintenance & monitoring of small reed bed	40,000	Guidance in construction, assistance in monitoring	
4.	-do-	Vishtec	Data collection on nursery formation completed. New bed under construction, to be completed by end June, 99.	Installation of nursery, maintenance and monitoring, land for new bed	160,000	Design, construction of plant scale reed bed including civil, electromechanical components and operation & monitoring	
5.	2/A- Pilot Reverse	ATH	Operational for one year. Operation to continue and to	Complete civil works, assistance in operation,	320,000	Subcontract for setting up complete unit, operation & monitoring of	38,783

	Osmosis (RO) unit		be completed by August, 99. Final report by September, 99.	maintenance and monitoring, bearing power cost of operation		system, additional monitoring equipment.	
6.	3 - UASB & fleshings	CLRI	All trials completed. Draft final report prepared.	Utilisation of existing reactor, civil works for modifications	70,000	Subcontract for installation of the additional units, operation and monitoring	52,300
7.	4- Bio-methanisation	Vishtec	Implementation in progress, Start up by Sep, 99.	Co-financing civil cost, assistance in operation, maintenance and monitoring	800,000	Cost sharing of total installation of the pilot unit & technical support	67,524
8.	5 - Glue/ Gelatine from fleshings		Field visit of expert to Nepal completed, DPR under preparation.			Field survey and feasibility study	6,800
9.	6- Mechanical desalting	Arafath Leathers	All field trials completed. Final report prepared. Technology package prepared & disseminated	Electrical works, assistance in operation and maintenance	20,000	Technical guidance for the trials, study on salt re-use	1,550
10	6-Manual desalting	Various tanneries		Operation of DODECA type desalting unit and collection/ utilisation of salt	25,000	Propagation of use of DODECA frame	
11	7- Land fill of sludge	Ranitec	Completed, first bed completely filled and covered, other beds 80-90% filled up, final report by Nov, 1999.	Providing land, civil works for the pilot land fill unit, operation, maintenance and monitoring	375,000	Technical guidance for operation & monitoring of the units, improvements in disposal site	24,870
12	-do-	Vishtec	In advanced stage of construction, expected to be completed by second week of July 1999.	Providing land, infrastructure like road etc.	180,000	Turnkey implementation of sludge disposal yard at Vishtec.	
13	-do-	Sidco	Completed. Operational for 18 months. Data collected regularly.	Complete construction of the land fill, operation, maintenance and monitoring	310,000	Technical guidance in setting up disposal site.	
14	8- Composting	Vishtec	First phase completed, second phase ongoing, to be completed by Nov. 1999.	Construction of composting units, operation, maintenance and monitoring	65,000	Providing technical assistance through national expert	10,750
15		Sidco	Continuous activity, permanent shed made, So far five rounds completed, monitoring and consolidation	Construction of shed, platform and assistance in constructing composting heaps. assistance in	85,000	Technical guidance.	

			of data continuing.	operation, maintenance and monitoring			
16	9- Irrigation	Sidco	All projects completed, continuous monitoring ongoing, Final report by Nov. 1999.	Providing land, implementation of irrigation projects at site 1 &2, Providing land for site-3, operation, maintenance and monitoring.	110,000	Providing technical guidance and monitoring of project	28,590
17		PKL	All projects completed, continuous monitoring ongoing, Final report by Dec. 1999.	Providing land, implementation of irrigation projects- Cassurina, Mangium & flowering plants, operation, maintenance and monitoring.	85,000	Monitoring of the project and co-ordination with agencies involved.	
18		Ranitec/ AISHTMA	All trials completed. Report made.	MoU with TNAU, providing land, assistance in implementation of the project, operation, maintenance and monitoring.	480,000	Monitoring and co-ordination	
19	12- Improved chrome tanning	Delta Leathers	All trials completed, final report made & technology package under review, will be ready for distribution by July 1999.	Piping, basement, drainage, operation, maintenance and monitoring.	190,000	Providing modifications in drum, feeding arrangement and speed, monitoring of the system	15,873
20	14- Solidification of sludge	Ranitec/ Vishtec/ Sidco	All trials completed, final report made, PDU closed.	Analysis of sludge samples, experiments as required.	30,000	Providing technical assistance through national expert	10,387
21	16- Improved solar evaporation	SSC Tannery	Trials nearing completion, to be completed by Nov, 1999 and final report by Dec 1999.	Piping, repair of existing solar pans, control room, assistance in operation, maintenance and monitoring.	210,000	Subcontract and purchase for design, implementation and monitoring of the complete system	38,686
			Total (in INR)		3,805,000		
			Total (in US Dollars)		89,572		US \$ 551,154

V.2. Model CETPs/ETPs

#	Counterpart	Activity	Status of the project	Counterpart activity done	Approximate cost (Rs.)	UNIDO activity	Approximate cost (USD)
22.	Ranitec	Upgradation of CETP	General: Upgradation activities nearing completion, Final report by Dec 1999.	Providing data for preparation of upgradation report and conducting trials as required.		Preparation of upgradation plan, technical assistance from national international experts and CTC	364,669
23.	Ranitec	Floating aerator 20 HP	Supplied, operational for 8 months.	Electrical works, Installation, operation & maintenance.	30,000	Supply of aerator and spares.	
24.	Ranitec	Pre-settlers	Completed, operational for 5 months.	Civil works for foundation, providing assistance in pipe laying and erection of pre-settlers. Operation & maintenance of pre-settlers.	450,000	Supply, installation, and commissioning of pre-settler, piping work for pre-settler.	
25.	Ranitec	Laboratory instruments	Supplied.	Providing electrical connections etc.	12,000	Supply of additional laboratory instruments	
26.	Vishtec	Upgradation of CETP	General: All activities planned are completed, Final report by Dec 1999.	Providing data for preparation of upgradation report.		Preparation of upgradation plan, technical assistance from national international experts	62,399
27.	Vishtec	Sludge tank & pump	Supplied	Electrical works & connection, operation & maintenance of the tank/pump.	10,000	Supply of trolley mountable sludge tank & mobile pump	
28.	Vishtec	Floating aerator 10 HP	Supplied.	Electrical works, Installation, operation & maintenance.	20,000	Supply of aerator and spares.	
29.	Vishtec	Laboratory instruments	Supplied.	Providing analytical table, electrical connections etc.	16,000	Supply of additional laboratory instruments	
30.	Vishtec	Instrumentation system	Installation completed, commissioning ongoing, to be regularly operational from mid July 1999.	Control room construction, assistance in electrical connections, operation, and maintenance of the system.	120,000	Turn key implementation and operation of automatic Instrumentation control system and display panel	
31.	PKL	Upgradation of ETP and environmental laboratory	All activities planned are completed, final report by Nov 1999.	Providing data for preparation of upgradation report.		Preparation of upgradation plan, technical assistance from national international experts and CTC	18,633

32.	PKL	Covering of sludge drying bed	Completed, First phase trial completed, second phase ongoing, completion of experiment & report by July 1999.	Assistance in implementation, operation & monitoring.	15,000	Technical guidance, preparation of upgradation plans.	
33.	PKL	Improvement in laboratory	Completed.	Providing computer, additional instruments for the laboratory	75,000	Supply of additional laboratory instruments and sampler	
		Total (In Indian rupees)			748,000		
		Total (in US Dollars)			17,608		445,701

Note

(1) The various improvements in the ETP of Meera Hussain Tannery were covered under the OSH improvements.

(2) The counter part activity indicated pertains to only those activities undertaken by counterparts against UNIDO inputs. Many other activities were done by counterparts as per the upgradation reports & guidance provided by UNIDO, the cost of which is not included in the above table.

APPENDIX VI. Pilot and Demonstration Units - PDUs

Overview with comments by the evaluation team

#	PDU	Counter part	Status of project	Comment
1.	1 - Reed bed	PKL	Operational for 10 months, monitoring continues, feeding increase to continue till Dec, 99.	Reed bed application is regarded as one of the best options for further, tertiary treatment of tannery effluents coming after being discharged from (C)ETP. This solution could contribute a lot to solving the TDS problem. In particular, when water discharged from the reed beds is applied for irrigation of nurseries (like in PKL Tannery)
2.	-do-	Ranitec	Operational for 10 months, data consolidated, relatively bigger plant under construction.	
3.	-do-	Sidco	Operational for 11 months, experiments as tertiary treatment completed, data consolidated, experiments with semi treated effluent to start June, 99.	
4.	-do-	Vishtec	Data collection on nursery formation completed. New bed under construction, to be completed by end June, 99.	
5.	2/A - Pilot Reverse Osmosis (RO) unit	ATH	Operational for one year. Operation to continue and to be completed by August, 99. Final report by September, 99.	For most of the tanneries out of reach, since high costs for installation and operation. Applicable for those tanneries with very high raw/fresh water costs
6.	3 - UASB & fleshings	CLRI	All trials completed. Draft final report prepared.	UASB techniques seem not very much suitable for tanneries be it CETPs or solid by-products treatment (like fleshings); especially for the latter purpose UASB is not very feasible; this an outstanding example for too much research oriented approach in PDU; one of the very few PDUs, not implemented in a company
7.	4 Bio-methanisation	Vishtec	Implementation in progress, Start up by Sep, 99.	Probably the most suitable option for treatment or further use of organic by-products/co-products of leather tanning
8.	5 - Glue/ Gelatine from fleshings		Field visit of expert to Nepal completed, DPR under preparation.	For countries like Nepal, Indonesia, and perhaps China and in some regions of Tamil Nadu an appropriate option
9.	6- Mechanical desalting	Arafath Leathers	All field trials completed. Final report prepared. Technology package	Very appropriate, effective and efficient Clean Technology option, which helps to solve the TDS problem close to source of waste generation
10	6-Manual	Various	prepared & disseminated	

11.	desalting 7- Land fill of sludge	tanneries Ranitec	Completed, first bed completely filled and covered, other beds 80-90% filled up, final report by Nov, 1999.	Since there is no proper solution for tannery sludge treatment available at the moment ? even in the industrialised countries, disposal of sludge in a secure landfill is the only appropriate and meaningful option
12	-do-	Vishtec	In advanced stage of construction, expected to be completed by second week of July 1999.	
13	-do-	Sidco	Completed. Operational for 18 months. Data collected regularly.	
14	8- Composting	Vishtec	First phase completed, second phase ongoing, to be completed by Nov. 1999.	Tests and development of solutions like these are a promising attempt to solve the sludge problem mentioned under # 11, 12, and 13 in this table. There remains still the problem of the accumulation of chrome in the compost and the subsequent dissemination of this heavy metal. After more reducing of chrome load in the sludge (by consequent application of CRP and other recycling techniques, simple precipitation, etc.) the content could be reduced
15		Sidco	Continuous activity, permanent shed made, So far five rounds completed, monitoring and consolidation of data continuing.	
16	9- Irrigation	Sidco	All projects completed, continuous monitoring ongoing, Final report by Nov. 1999.	See also # 1 to 4 in this table. Very good contribution to solving the TDS problem
17		PKL	All projects completed, continuous monitoring ongoing, Final report by Dec. 1999.	
18		Ranitec/ AISHTMA	All trials completed. Report made.	
19	12- Improved chrome tanning	Delta Leathers	All trials completed, final report made & technology package under review, will be ready for distribution by July 1999.	Unfortunately this was the only PDU, which was dealing directly with in-plant techniques (Clean technology/Cleaner Production options per se). At the same time it was the most successful PDU. Solutions like this should be promotedly used in the next phase of the programme. This is a nice Cleaner Production approach, which could be the crystallisation point for more options like this in SME tanneries as well as in large-scale companies (e.g. for lime liquor recycling, or low chemicals use in many baths. low float techniques.

20	14- Solidification of sludge	Ranitec/ Vishtec/ Sidco	All trials completed, final report made, PDU closed.	advanced techniques like hair saving liming or green fleshing) Analysis of sludge samples, experiments as required. Further use in view of chromium content is to be considered
21	16- Improved solar evaporation	SSC Tannery	Trials nearing completion, to be completed by Nov, 1999 and final report by Dec 1999.	This technique requires still to be economically thoroughly analysed, since the effectiveness, efficiency and appropriateness seems to be proved

APPENDIX VII. List of Technical Reports and Publications

This list was prepared by RePO staff.

US/RAS/92/120 Regional Programme for Pollution Control in the Tanning Industry in South East Asia

INDEX OF REPORTS PREPARED BY REPO EXPERTS/CONSULTANTS

VII.1. CLEANER TECHNOLOGIES

VII.1.1 General

#	Subject	Title	Author	Year
22.	CT-General	Environmental aspects of processing and trade in hides and skins and leather.	Jakov Buljan	September 1994.
23.	CT-General	Evaluation of tannery at Gambiran & processing methods at Garut Cluster	David Cruickshank	February, 1995
24.	CT-General	Analytical Methods for the Determination of Aromatic Amines.	J.M. Gigante	1996
25.	CT-General	Cleaner Leather production methods	K. H. Munz	
26.	CT-General	Evaluation of waste minimization and recycle operation during raw to wet blue process in KKSK Leathers	S. Rajamani/ M. Viswanathan	
27.	CT-General	Report on waste minimization efforts in a small scale tannery	K. V. Emmanuel	October, 1996
28.	CT-General	Mass Balance in leather processing	J. Buljan, G. Reich & J. Ludvik	May 1997
29.	CT-General	Cleaner technology options - case study of a small scale tannery	A. Sahasranaman/ K. V. Emmanuel	June, 1997
30.	CT-General	Tannery pollutant standards comparison.	Jakov Buljan/ Valentin Post	October, 1997
31.	CT-General	Solid wastes generated in tanneries and their utilisation	Valentin Post	1998
32.	CT-General	Advanced Chrome Tanning Methods Direct Recycling, High Exhaust, Chrome Recovery and Re-use.	Ms. Catherine A. Money	1998
33.	CT-General	Cleaner tanning technology options.	Jakov Buljan	1998
34.	CT-General	Recycling / recovery of floats and chemicals.	Michel Aloy	1998
35.	CT-General	Cleaner tanning technology currently practised in the region.	A. Sahasranaman / Valentin Post	September, 1998,
36.	CT-General	Overview / mass balance in leather processing.	Jakov Buljan	September, 1998
37.	CT-General	Sources of pollution in leather processing.	Dr. S. Rajamani	September, 1998
38.	CT-General	Safe preservation of raw hides / skins and wet blue.	Dr. C. Hauber	September, 1998

39.	CT-General	Pollution reduction in soaking.	M. Viswanathan	September, 1998
40.	CT-General	Low salt pickling and cleaner technology in degreasing.	Mr. Michel Aloy	September, 1998
41.	CT-General	Case studies / Panel discussion - Identifying obstacles to adoption of cleaner tanning in the region.	RePO & KSKS, Mohamed Ali	September, 1998
42.	CT-General	Cleaner technologies in post tanning operations.	JM Gigante	September, 1998
43.	CT-General	Analytical methods for determining aromatic amines	JM Gigante	September, 1998
44.	CT-General	Cleaner technologies in Finishing Operations.	J. M. Gigante	September, 1998
45.	CT-General	Cleaner technologies and trade / commercial aspects.	A. Sahasranaman / Valentin Post	September, 1998
46.	CT-General	The scope for decreasing the pollution load in leather processing	J. Ludvik	September 1998
47.	CT-General	Waste minimisation technologies	Jakov Buljan/ A. Sahasranaman	February 1999.
48.	CT-General	Report on cleaner technology options in Nepal	K. Parthasarathy	June, 1999

VII.1.2 Chrome Management

#	Subject	Title	Author	Year
1	Chrome management	Chrome Management	Mr. Covington	1996
2	Chrome management	Technology Package - A system for recovery and reuse of chromium from spent tanning liquor using magnesium oxide and sulphuric acid	Dr. S. Rajamani	1997
3	Chrome management	Implementation and performance of central chrome recovery system, Birgunj, Nepal,	Dr. S. Rajamani	1997
4	Chrome management	Chrome management.	A. D. Covington	March 1997
5	Chrome management	Chrome waste management.	S. Rajamani	October, 97
6	Chrome management	Chrome management in the tanyard	J. Ludvik	September 1998
7	Chrome management	Material balance of chrome tanning and chrome management - overview.	Jakov Buljan	September, 98
8	Chrome management	Improved conventional chrome tanning - A case study [PDU / 12]	Pervez Alam	September, 98
9	Chrome management	Advanced chrome tanning methods (direct recycling, high exhaust, chrome recovery & reuse, etc.)	C. Money	September, 98
10	Chrome management	Chrome free tanning & wet white production	Mr. Michel Aloy	September, 98
11	Chrome management	Chrome balance in leather processing,	J. Ludvik	September 1998.

VII.1.3 Others

#	Subject	Title	Author	Year
1	Preservation	Environmental impact of most frequently used and/or promoted hide and skin preservation methods.	J. Ludvik	April 1994.
2	Preservation	Study of flow of hides and skins in the state of	Dr. T. J. Devassy	June, 1996

		Tamil Nadu and alternate techniques to replace salt curing.		
3	Unhairing	Report on trials of enzymatic unhairing with Novo Nordisk enzymes	K. V. Emmanuel	October, 1997
4	Unhairing	Hair-save unhairing methods in leather processing	Willy Frendrup	June 1998
5	Desalting	Desalting of hides / skins	S. Rajamani	September, 98
6	Deliming	Ammonia-free deliming.	S. Rajamani, Michel Aloy	September, 98
7	Liming	Direct recycling of liming float.	Mr. Michel Aloy	September, 98
8	Preservation	Raw material - Preservation storage - Feasibility of saltless curing.	Michel Aloy	September, 98
9	Preservation	Preservation of Raw and Wet Blue Hides and Skins.	Ms. Christina Hauber	September, 98

VII.2. SOLID WASTE & SLUDGE TREATMENT

VII.2.1 Solid Wastes

#	Subject	Title	Author	Year
1	Solid wastes	Solids waste generated in the tannery and ETP and sludge disposal	Valentin Post	July, 1996
2	Solid wastes	Processing of certain abattoir by-products into pet foods & pet treats	N. Muralidhara Rao	1996
3	Solid wastes	Solid wastes from tannery operation	Valentin Post	Feb, 97
4	Solid wastes	Solid wastes from tanneries - prevention, reduction and utilisation established and emerging technologies, Salt to Sludge.	Valentin Post	October, 97
5	Solid wastes	Mission report on disposal of solid waste in tanneries and meat processing units (2 reports)	D. V. R. Prakash Rao	Dec, 1997
6	Solid wastes	Sources of solid waste and conversion.	A. Sahasranaman / Valentin Post/ Michel Aloy	September, 98

VII.2.2 By-products from Tannery Wastes

#	Subject	Title	Author	Year
1	Trimming disposal	Establishing a Dog Chew Manufacturing Plant using Raw Hide Trimmings and Limed Splits of Hides.	N. Muralidhara Rao	April, 98
2	Disposal of trimmings & shavings	Establishing a semi-mechanised leather board manufacturing plant using chrome shaving and vegetable tanned trimming,	N. Muralidhara Rao	April, 98.
3	Disposal of fleshings	Establishing protein meal plant using tannery fleshing as a source of animal protein in poultry feed formulations.	N. Muralidhara Rao	April, 98
4	Disposal of fleshings & trimmings	Establishing a glue / technical gelatine plant using raw trimming and limed fleshing as a source of raw material.	N. Muralidhara Rao	April, 98

VII.2.3 Sludge Management

#	Subject	Title	Author	Year
1	Sludge management	Effect of tannery effluent treatment sludge on w heat	Shanmughavadivu.	July, 1997
2	Sludge management	Characterisation of tannery sludge	S. Rajamani/ K.V. Emmanuel	September, 1997
3	Sludge management	Sludge thickener & sludge dewatering units.	Michel Aloy, CTC	October, 1997
4	Sludge	Sludge drying beds.	S. Rajamani	October, 1997

	management			
5	Sludge management	Solid waste generation in the various tanning operations and management.	Valentin Post	October, 1997
6	Sludge management	Sludge management and disposal	Michel Aloy	October, 1997
7	Sludge management	Project report on temporary pilot safe disposal site for sludge from common effluent treatment plant for tanneries	Valentin Post	December, 1997

VII.3. EFFLUENT TREATMENT

VII.3.1 General

#	Subject	Title	Author	Year
1	ETP Operation	Basic operation and control of effluent treatment plants for the tanning industry.	Giuseppe Clonfero	March 1994
2	General	Electrical maintenance of a CETP	A. Bentick.	July, 1996
3	General	General principles and types of treatment system.	S. Rajamani	October, 97
4	General	Lagooning systems.	Michel Aloy	October, 97
5	General	Anaerobic treatment, UASB and other advanced reactors.	Dr. S. Rajamani	October, 97
6	General	Aerated lagoon, oxidation ditch and conventional activated sludge type process.	Michel Aloy	October, 97
7	General	High rate algal ponding system.	Johan Barnard	October, 97
8	General	Presentation of computer application on ETP design.	J. Buljan, M. Bosnic	October, 97
9	General	Extended aeration, secondary clarifier & bio sludge recalculation,	M. Bosnic	October, 97
10	General	Aeration system for oxidation ditches - cage rotors & other type mixers.	Michel Aloy	October, 97
11	General	Dissolved air flotation, oxidation ditch and secondary clarifier.	Mr. Song Xin, Prof Wu, Mr. Shen Zhen Huan	October, 97
12	General	CETP management	A. Sahasranaman	October, 97
13	General	Pollutants in tannery effluents, definitions and environmental impact, limits for discharge into water bodies and sewers.	M. Bosnic, J. Buljan and R. P. Daniels	February 1998

VII.3.2 CETPs

#	Subject	Title	Author	Year
1	CETP	Preliminary report on effluent treatment at Nepal	Srdjan Selanec	May, 1994
2	CETP	Preliminary design for CETP at Garut	M. Bosnic	July, 1994
3	CETP	Management of collection & conveyance network of CETP	K. V. Emmanuel	July, 1996
4	CETP	Mechanical maintenance of a CETP	K. Suresh	July, 1996
5	CETP	Managing a Common Effluent Treatment Plant	A. Sahasranaman / K.V. Emmanuel	October 1997.
6	CETP	Study on Tannery Waste Discharges from Hazaribagh Cluster of Tanneries, Dhaka, Bangladesh.	S. Karam Ali Ahmed	1997
7	CETP	Preparatory Assistance in Treatment of Tannery Waste of CLG-Calcutta Leather Complex.	Srdjan Selanec	March, 1999
8	CETP	Screen chamber, collection tank & equalisation system.	S. Rajamani	October, 97
9	CETP	Commissioning report of ETP in Nepal	Enkem Engineers	January, 1999
10	CETP	Technical report on field mission to Indonesia	Martin Van Vliet	November, 1997
11	CETP	Technical report on field mission to Indonesia	Martin Van Vliet	June, 1997
12	CETPs	Dossier on: Ranitec/Ranipet (SIDCO)/ Ambur / Pemambut / Vanivambadi / Pallavaram CETPs (7	K. V. Emmanuel	May, 1996

		reports)		
13	CETPs	Assistance in CETPs in Tamil Nadu State	G. Clonfero	May, 1996
14	CETPs	Mission report on assistance in CETPs in Tamil Nadu State,	Michel Aloy	July, 1996
15	CETPs	A practical guide on problems & solutions in CETP - first draft	K. V. Emmanuel	June, 1999
16	CETPs	CETP Management & costs	A. Sahasranaman/ K. V. Emmanuel	Feb, 1998
17	CETPs	Management of a CETP	A. Sahasranaman/ K. V. Emmanuel	July, 1998
18	CETPs	CETP operation & maintenance	K. V. Emmanuel	June, 1997
19	CETPs	Comparison of performance of CETPs in Tamil Nadu - an over view	K. V. Emmanuel	Dec, 1998

VII.3.3 Laboratory

#	Subject	Title	Author	Year
1	Laboratory	Technical report: Manual on laboratory equipment and reagents	Michel Aloy	February 1994.
2	Laboratory	Laboratory management for better monitoring of CETPs	K. V. Emmanuel	July, 1996
3	Laboratory	Laboratory management	Valentin Post	July, 1996
4	Laboratory	Better monitoring for effective CETP operation	K. V. Emmanuel	September, 1996
5	Laboratory	Laboratory management.	K.V. Emmanuel	October, 1997
6	Laboratory	Operation of effluent treatment plant & monitoring,	K.V. Emmanuel	October, 1997
7	Laboratory	Report on modernisation of laboratory in the CETP, Ranitec	K. V. Emmanuel	Nov, 1997

VII.4. PILOT DEMONSTRATION UNITS

#	Subject	Title	Author	Year
1	PDU/1	Natural Treatment Systems in tannery effluent treatment	Richard P. Daniels	1996
2	PDU/1	Feasibility study on application of reed bed technology	RePO	October, 1997
3	PDU/1	Project report on Application of Reed Bed Technology for Effluent Treatment	The Solutions Centre	December, 1997
4	PDU/1	Completion report on reed bed construction at PKL	G. D. Constructions	August, 1998
5	PDU/1	First Quarterly Report, Application of Reed Bed Technology for Effluent Treatment	The Solutions Centre	August, 1998
6	PDU/1	Second Quarterly Report, Application of Reed Bed Technology for Effluent Treatment	The Solutions Centre	October, 1998
7	PDU/1	Progress report on reed bed units of RePO, UNIDO	K. V. Emmanuel	November, 1998
8	PDU/1	Reed bed treatment for Industrial effluents	G. Anand, TSC	Nvember, 1998
9	PDU/1	Third Quarterly Report, Application of Reed Bed Technology for Effluent Treatment	The Solutions Centre	December, 1998
10	PDU/1	Fourth Quarterly Report, Application of Reed Bed Technology for Effluent Treatment	The Solutions Centre	February, 1999
11	PDU/1	Interim report on performance of reed bed projects of RePO, UNIDO	K. V. Emmanuel	March, 1999
12	PDU/1	Project report on reed bed project at CETP, Melvisharam	The Solutions Centre	March, 1999
13	PDU/1	Reed bed treatment Vs conventional treatment: UNIDO's experience	K. V. Emmanuel	April, 1999
#	Subject	Title	Author	Year
1	PDU/2	Ultrafiltration for tannery effluent treatment	Mladen Bosnic	1997

2	PDU/2	First progress on Pilot RO unit operation at ATH tannery, Melvisharam	K. V. Emmanuel	April, 1997
3	PDU/2	Membrane technologies for tannery effluent treatment	BLC	October, 1997
4	PDU/2	Feasibility of application of membrane technologies for tannery effluent treatment	RePO	October, 1997
5	PDU/2	Implementation of pilot RO unit at ATH tannery, Melvisharam	Aqua Chemicals & System Mfg.	December, 1997
6	PDU/2	Closure report on PDU/2B : Ultrafiltration for tannery float recycle	RePO	April, 1998
7	PDU/2	Closure report on PDU/2C : Ultrafiltration for tannery effluent treatment	RePO	July, 1998
8	PDU/2	First Progress Report - Sampling, Testing and Evaluation of the Pilot Membrane System (RO) at ATH Tannery - Melvisharam -	CLRI	November, 1998
9	PDU/2	Report on operation of pilot RO unit at ATH tannery, Melvisharam	K. V. Emmanuel	November, 1998
10	PDU/2	Interim Report on Pilot RO unit operation	Aqua Chemicals & System Mfg.	February, 1999
11	PDU/2	Progress report on operation of pilot RO unit at ATH tannery, Melvisharam for the period Nov 98 - March, 99	K. V. Emmanuel	April, 1999

#	Subject	Title	Author	Year
1	PDU/3	Pilot scale study of anaerobic digestion of fleshings and tannery waste water in UASB system at CLRI	J. W. Vangronestijn	December, 1997
2	PDU/3	Progress report on application of fleshings to UASB reactor	CLRI	October, 1998
3	PDU/3	Application of fleshings to UASB reactor -draft final report	CLRI	February, 1999

#	Subject	Title	Author	Year
1	PDU/4	Biomethanisation of Tannery Sludge and Fleshings	Dr. S. Badrinath	1997
2	PDU/4	Biomethanisation of tannery sludge & fleshings	Michel Aloy	Oct, 1997
3	PDU/4	Anaerobic processing of fleshings	J. W. Vangronestijn	Apr, 1998

#	Subject	Title	Author	Year
1	PDU/6	Mechanical desalting and reuse of dusted salt in tannery pickling operation ? Draft final report	M. Viswanathan/ S. Rajamani	June 1998
2	PDU/6	Mechanical / manual desalting of hides/skins and reuse of dusted salt in pickling operation in a tannery	M. Viswanathan/ S. Rajamani	Oct, 1998
3	PDU/6	Technology Package - Mechanical / manual desalting of hides/skins and reuse of dusted salt in pickling operation	M. Viswanathan/ S. Rajamani	Jan, 1999

#	Subject	Title	Author	Year
1	PDU/7	Safe disposal of tannery solid waste and sludge (landfill)	Pentti Rantala	March, 1996
2	PDU/7	Feasibility study of a landfill for tannery sludges at Da Chang Industrial Complex, Shanghai, China	Luigi Bruni and Alessandro,	June 1996.
3	PDU/7	Safe disposal of sludge - technical & financial proposal	Valentin Post	1996
4	PDU/7	Report on land fill at Ranitec CETP	Valentin Post	1996
5	PDU/7	Report on improvement of land fill at Ranitec	Valentin Post/K. V. Emmanuel	1997
6	PDU/7	Land fill manual first draft	CTC, France	1997

7	PDU/7	Report on land fill operation, leachate: quality and quantity	K. V. Emmanuel	Nov, 1997
8	PDU/7	Land fill manual second draft	Valentin Post	1998
9	PDU/7	Mass Balance of sludge land fill at Ranitec - first part	K. V. Emmanuel	July, 1998
10	PDU/7	Project report on simplified land fill at Vishtec	Sw aminathan	December, 1998
11	PDU/7	Land fill manual final draft	RePO/CTC	March, 1999
12	PDU/7	Mass balance (second phase) of sludge land fill at Ranitec	K. V. Emmanuel	April, 1999

#	Subject	Title	Author	Year
1	PDU/8	Draft final report on composting of tannery sludge	Sultan Ismail	May, 1998
2	PDU/8	Composting of tannery sludge	Sultan Ismail	July, 1998

#	Subject	Title	Author	Year
1	PDU/9	Report on natural treatment systems/ agricultural experiments using treated tannery effluent	Shanmughavadivu	1996
2	PDU/9	Report on settling up irrigation plot for utilisation of treated effluent from Ranitec	TNAU Coimbatore	1996
3	PDU/9	Proposal for utilisation of treated effluent for irrigation at Sidco	Shanmughavadivu.	1998
4	PDU/9	Report on settling up irrigation plot at Sidco CETP	ILIFO/ Valentin Post	1997
5	PDU/9	Monitoring report on irrigation using treated effluent first plot	Shanmughavadivu.	1997
6	PDU/9	Proposal for settling up 1600 square meter irrigation plot at Sidco CETP	Valentin Post/ ILIFO	1998
7	PDU/9	Final report on experiment using treated effluent at Ranitec & PKL	TNAU, Coimbatore.	Mar, 1998
8	PDU/9	Monitoring report on irrigation using treated effluent first plot	Shanmughavadivu.	July, 1998
9	PDU/9	First monitoring report on irrigation using treated effluent at PKL	D. Rajamurthy/ K.V. Emmanuel	July, 1998
10	PDU/9	Second monitoring report on irrigation using treated effluent at PKL	D. Rajamurthy/ K.V. Emmanuel	Oct, 1998
11	PDU/9	First monitoring report on utilisation of treated effluent at Sidco CETP (1600 m ²)	Valentin Post	Oct, 1998

#	Subject	Title	Author	Year
1	PDU/11	Report on effluent treatment system suggested for Magetan, Indonesia	BLC	1997

#	Subject	Title	Author	Year
1	PDU/12	Improved conventional chrome tanning? Phase-1 Report	M. Viswanathan/ S. Rajamani/ Pervez Alam	Feb, 1998
2	PDU/12	Improved conventional chrome tanning? Progress report: 31 March - 3 May 1998	M. Viswanathan/ S. Rajamani/ Pervez Alam	May, 1998
3	PDU/12	Improved conventional chrome tanning-Progress Report No.2: 4 May 1998 ? 2 July 1998	M. Viswanathan/ S. Rajamani/ Pervez Alam	July, 1998
4	PDU/12	Improved conventional chrome tanning? Draft Final Report	M. Viswanathan/ S. Rajamani/ Pervez Alam	Nov, 1998
5	PDU/12	Improved conventional chrome tanning	M. Viswanathan/	Jan, 1999

S. Rajamani/
Pervez Alam

#	Subject	Title	Author	Year
1	PDU/14	Preliminary report on solidification of sludge from tannery ETPs	Sw aminathan	1997
2	PDU/14	Interim report on solidification of sludge from tannery ETPs	Sw aminathan	February, 1998
3	PDU/14	Report on solidification and stabilisation of sludge from tannery effluent treatment	Sw aminathan	May, 1998

#	Subject	Title	Author	Year
1	PDU/15	PDU/15 final report	A. Sahasranaman/ S. Rajamani	July, 1998

#	Subject	Title	Author	Year
1	PDU/16	Design, Development and Evaluation of Solar Augmented Evaporation Ponds for Treatment of Segregated Tannery Effluents (Soak Liquor)-A Project Proposal	IIT	Jan, 1998
2	PDU/16	First Progress Report with Design Drawings - Improved solar evaporation	IIT	July, 1998
3	PDU/16	Third Progress Report - Improved solar evaporation	IIT	May, 1999
4	PDU/16	Commissioning and Preliminary Performance of Pilot Demonstration Unit on Improved solar evaporation.	Dr. S. Rajamani	Jan, 1999

VII.5. MODEL CETPs/ETPs

#	Subject	Title	Author	Year
1	Ranitec	Evaluation of CETP performance & recommendations	K. V. Emmanuel/ Valentin Post	July, 1997
2	Ranitec	Evaluation of laboratory in Ranitec	K. V. Emmanuel	August, 1997
3	Ranitec	Report on trial operation of centrifuge & filter press at Ranitec	K. V. Emmanuel	January, 1998
4	Ranitec	Report on performance of pre-treatment units in Ranitec	K. V. Emmanuel	March, 1998
5	Ranitec	Report on implementation of new environmental laboratory	K. V. Emmanuel	March, 1998
6	Ranitec	Report on upgradation of CETP - third version	RePO	April, 1998
7	Ranitec	Interim report on CETP performance & improvement	K. V. Emmanuel	August, 1998
8	Ranitec	Report on performance of pre-settler	Dr. S. Rajamani	March, 1999
9	Ranitec	Report on upgradation of CETP, Ranitec - first draft	RePO	November, 1998

#	Subject	Title	Author	Year
1	Vishtec	Evaluation of CETP performance & recommendations	K. V. Emmanuel/ Dr. S. Rajamani	July, 1997
2	Vishtec	Report on upgradation of CETP first draft	RePO	August, 1997
3	Vishtec	Report on upgradation of CETP	RePO	October, 1997

#	Subject	Title	Author	Year
1	PKL	Report on performance of the ETP	K. V. Emmanuel	November, 1996
2	PKL	Proposal for improvement of monitoring system at	Valentin Post/K. V.	January, 1997

3	PKL	PKL Report on performance of Wersche treatment system at PKL	Emmanuel Jurgen Hannak/K. V. Emmanuel	April, 1997
4	PKL	Report on performance of automatic chemical dosing system at PKL	K. V. Emmanuel	December, 1997
5	PKL	Report on upgradation of environmental laboratory at PKL	K. V. Emmanuel	January, 1998
6	MHT	Report on upgradation of effluent treatment plant	K. V. Emmanuel	June, 1998
7	PKL	Report on performance of Technoconcept screen at PKL	K. V. Emmanuel	August, 1998
8	PKL	Proposal for study of dewatering of sludge drying beds provided with cover	K. V. Emmanuel	August, 1998
9	PKL	Report on experiment with ozone with effluent at various sections at PKL	K. V. Emmanuel	March, 1999
10	PKL	Report on performance improvement of ETP at PKL	K. V. Emmanuel	March, 1999
11	PKL	Study of segregated effluent streams at PKL	D. Rajamurthy/K. V. Emmanuel	June, 1999
12	MHT	Report on upgradation of ETP	Hannak/K. V. Emmanuel	June, 1998
13	MHT	Study report on anaerobic treatment with and without lamps at MHT	K. V. Emmanuel	June, 1999

VII.6. US/IND/97/124

#	Subject	Title	Author	Year
1	Output-1	Low waste environmentally acceptable leather finishing operations - Phase-1 Draft Report	K.S. Jayaraman/ M. Viswanathan/ S. Rajamani	June 1998
2	Output-1	Draft report on Low waste environmentally acceptable leather finishing operations	M. Viswanathan	March 1999
#	Subject	Title	Author	Year
1	Output-2	Baseline data for CETP, Amburtec	Rajamani	September, 1998
2	Output-2	Settling studies in Amburtec effluent	Masood Javed	October, 1998
3	Output-2	Project report on upgradation of the CETP	TEH Projekt	November, 1998
#	Subject	Title	Author	Year
1	Output-3	Completion report of mini forest project	Shanmughavadiyu	January, 1999
2	Output-3	Project report on rehabilitation of degraded land	Jayaraman	January, 1999
#	Subject	Title	Author	Year
1	Output-4	Feasibility report on reduction of sludge volume by anaerobic digestion	K. V. Emmanuel	November, 1997
2	Output-4	Feasibility report on anaerobic digestion of soak sludge	S. Rajamani	October, 1998
3	Output-4	Project report on anaerobic digestion of sludge at Vaniyambadi	S. Rajamani	November, 1998

VII.7. OCCUPATIONAL SAFETY & HEALTH

#	Subject	Title	Author	Year
4	OSH	Sample survey schedule for occupational safety and health at work in tanneries.	J. Buljan, J. Hannak, G. Jayaraj	August 1996
5	OSH	Occupational safety and health trainer's manual (in English)	A. Sahasranaman, J. Hannak, V. Van den Bossche, M. Alexander	

6	OSH	Occupational safety and health trainer's manual (in Bahasa Indonesia)	A. Sahasranaman, J. Hannak, V. Van den Bossche, M. Alexander	
7	OSH	Occupational safety and health in the tanning industry - OSH training video (VHS-PAL)		
8	OSH	Final report US/RAS/92/120/17-66 containing workshop reports for OSH workshops in Chennai (January 1999), Vaniyambadi (February 1999) and Dindigul (March 1999), India		1999
9	OSH	Final report US/RAS/92/120/17-05 containing workshop reports for OSH workshops in Yogyakarta (February 1999), Garut / Jakarta (March 1999) and Surabaya (April 1999), Indonesia	Ms. Suliestiyah	
10	OSH	Occupational safety and health standards at work in the tanning industry in India (Tamil Nadu)	Jurgen Hannak & G. Jayaraj	January 1997
11	OSH	Occupational safety and health standards at work in the tanning industry in China.	Mrs. Song Xian Wen	March 1997
12	OSH	Occupational safety and health standards at work in the tanning industry in Nepal	Uttam K. Kunwar	March 1997
13	OSH	Comparative overview of occupational safety and health legislation	Jurgen Hannak	April 1997
14	OSH	Occupational safety and health standards at work in the tanning industry in Indonesia	Mrs. Suliestiyah Wrd	May 1997
4915	OSH	Occupational safety and health standards at work in the tanning industry in South East Asia - Regional Summary.	Jurgen Hannak	July 1997
16	OSH / WID	Regional Workshop for Co-ordination and Planning on WID and OSH - Proceedings of Workshop	RePO	July 1997
17	OSH	Memorandum of understanding for establishment of OSH cell in Sri Ramachandra Medical College & Research Institute, Chennai, India	RePO	September 1997
18	OSH	Workshop report for OSH workshop at Vaniyambadi, India	RePO	October 1997
19	OSH	Occupational safety and health reference manual for leather manufacture (in Bahasa-Indonesia)	J. Buljan, A. Sahasranaman, J. Hannak, V. Van den Bossche, F. Floretti, M. Alexander	April 1998
20	OSH	Report - Implementation of OSH improvement in three selected tanning industry in Indonesia	Mrs. Suliestiyah Wrd	April 1998
21	OSH	Safety handbook on how to deal with hydrogen sulphide gas in tanneries and effluent treatment plants	J. Buljan, J. Hannak, G. Jayaraj	June 1998
22	OSH	Workshop report for OSH workshop at Ambur, India	RePO	July 1998
23	OSH	Memorandum of understanding for provision of OSH services, Yogyakarta, Indonesia - IRDLAI	RePO	December 1998
24	OSH	Reports on occupational safety and health monitoring conducted by OSH Cell, Sri Ramachandra Medical College & Research Institute, India 1) At M. A. Khizar Hussain & Sons, Ranipet 2) At Farida Shoes, Bangalore 3) At Shafeeq Shameel & Co, Ambur 4) At T. Abdul Wahid & Co, Ambur		August - December 1998

25	OSH	Proceeding of National OSH Seminar, Yogyakarta, Indonesia		December 1998
26	OSH	Workshop report for OSH workshop at Ranipet, India	RePO	December 1998
27	OSH	Workshop report for OSH workshop at Shanghai, China		December 1998
28	OSH	Occupational safety and health reference manual for leather manufacture (in English)	J. Buljan, A. Sahasranaman, J. Hannak	February 1999
29	OSH	Proceedings of national OSH seminar and technical seminar on Industrial hygiene, Chennai, India	RePO	February 1999
30	OSH	Workshop report for OSH workshop at Hangzhou, China		March 1999
31	OSH	Report on OSH site - H. Mohamed Osman & Co, Vaniyambadi	G. Jayaraj, J. Hannak	March 1999
32	OSH	Report on OSH site - Presidency Kid Leather, Kannivakkam, India	G. Jayaraj, J. Hannak	March 1999
33	OSH	Report on OSH site -G. Govindarajulu Naidu & Co, Pallavaram, India	G. Jayaraj, J. Hannak	March 1999
34	OSH	Report on OSH site -P. Meera Hussain Tannery, Rathagiri, India	G. Jayaraj, J. Hannak	March 1999
35	OSH	Report on OSH site -TALCO -Ranitec, Ranipet, India	G. Jayaraj, J. Hannak	March 1999

VII.8. WOMEN IN DEVELOPMENT

#	Subject	Title	Author	Year
1	WID	Status of women's participation in the tanning industry in India	Madhura Chatrapathy	November 1996
2	WID	Status of women's participation in the tanning industry in South East Asia - Regional Summary	Jurgen Hannak	June 1997
3	WID	Training manual for women skill upgradation in the tanning industry		
4	WID	Status of women's participation in the tanning industry in Nepal	Uttam K. Kunwar	March 1997
5	WID	Status of women's participation in the tanning industry in China	Mrs. Song Xian Wen	April 1997
6	WID	Status of women's participation in the tanning industry in Indonesia	Mrs. Suliestiyah Wrd	May 1997
7	WID	Strategies for increasing women's participation in the tanning industry in South East Asia - China, India, Indonesia, Nepal.	Isa Baud	June 1997

VII.9. ECO LABELLING

#	Subject	Title	Author	Year
1	Eco-label	Recent developments in eco-labelling with regard to leather and leather products - background paper, UNIDO expert group meeting Vienna	Willy Frendrup	March 1997
2	Eco-label	Project proposal for pilot scale international eco-label for leather (second draft)		
3	Eco-label	Occupational safety and health standards at work in the tanning industry in South East Asia	Jurgen Hannak	April 1997
4	Eco-label	Workshop on international eco-label for leather, Chennai, India, October 1997 - proceedings	RePO	October 1997
5	Eco-label	Workshop on international eco-label for leather, Yogyakarta, Indonesia, May 1998 - Proceedings	RePO	May 1998

6	Eco-label	Workshop on international eco-label for leather, Beijing, China, November 1998 - Proceedings	RePO	November 1998
7	Eco-label	Incentive schemes for the promotion of environmental performance of industry with particular reference to the leather industry	Vijayalakshmi Rajagopalan	March 1999