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ENGLISH

PESTICIDES DEVELOPMENT PROGRAMME IN INDIA :

DP/IND/80/037

INDIA .

Technical report: Findings and recommendations for strengthening the analytical laboratory of PDPI*

Prepared for the Government of India
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of T. A. Antazo,
UNIDO consultant in quality control of pesticides

United Nations Industrial Development Organization

Vienna

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ACKNOWLEDGMENT

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ABSTRACT

One of the objectives of the UN-assisted Pesticide Development Programme India (DP/IND/80/037) is the improvement of the country's pesticide formulation capability through the conduct of training courses on various aspects of formulation technology and making available to industry its analytical services for product quality control.

The author was in India during the period 20 October to 29 December 1985 as consultant in quality control of pesticides. The author's duties were: i) to guide and train the scientists/analysts of the PDPI Center in the analysis of various pesticide formulations; ii) to impart training in the operation and maintenance of analytical instruments; iii) to give lectures and demonstrations on the application of gas chromatography and high pressure liquid chromatography for the analysis of pesticides; and iv) to review and evaluate the existing staff, laboratory equipment and facilities and suggest needed augmentation required to support on a reasonable basis the implementation of PDPI objectives.

This report covers the author's activities, suggestions to improve work efficiency in the instrument room, proposals for vital supplemental equipment and spare parts and the abstracts of three papers presented during the training programme on pesticide formulation technology. It also makes mention of some observations made by the author regarding key requirements of the PDPI, foremost of which is the recruitment of trained and qualified manpower to form an Analytical Development Group.

CONTENTS

INTRODUCTION

A. Scope of the mission

The project "Pesticide Development Programme in India" (DP/IND/80/037) is a multipronged activity geared towards the strengthening and improvement of the pesticide formulation industry in the country. Established with UNDP/UNIDO assistance, this project began in July, 1981 and is being implemented by the Hindustan Insecticides Ltd. (HIL) on behalf of the Government of India. Its Center is based at Udyog Vihar, Gurgaon, Haryana, some 25 km from Delhi, and is equipped with research and technology development facilities in the many aspects of pesticide formulation.

One of its objectives is the training of manpower for the pesticide industry with special emphasis on the small-scale sector. It is widely recognized that the quality control testing facilities of small-scale industrial units need strengthening and improvement.

The PDPI has established the necessary infrastructure and facilities for the quality control of pesticides and has formulated training capsules to cater to the different needs of the pesticide formulation industry. It is with the training of personnel and with making available the services of sensitive sophisticated analytical instrumentation that PDPI can assist the small-scale formulators. But before it can fully embark on this activity, the PDPI needs to firm up its position and assess its capability to undertake the responsibility.

For this reason, the author was in India as consultant in the quality control of pesticides during the period 20 October to 29 December 1985. The author's duties were:

i) To guide and train the scientists/analysts of the PDPI Center in the analysis of various pesticide formulations;

ii) To impart training in the operation and maintenance of analytical instruments;

iii) To give lectures and demonstrations on the application of gas chromatography and high pressure liquid chromatography for the analysis of pesticides;

iv) To review and evaluate existing staff, laboratory equipment and facilities and suggest needed augmentation required to support on a reasonable basis the implementation of PDPI objectives.

B. Background

The production of pesticides in India is largely in the hands of the private sector. It is built around 32 large industrial units engaged in the manufacture of about 50 technical grade pesticides and over 400 small-scale formulators. An estimated total annual formulation capacity is of the order of 1.6 million metric tons of formulated products. The small-scale sector accounts for 85 to 90 per cent of the total formulation capacity.

The major producer of pesticides in the public sector is Hindustan Insecticides Limited. It is under the administration of the Ministry of Chemicals and Fertilizers and has manufacturing units in Delhi, Cochin and Rasayani. These units are well-equipped research and development facilities for technical and formulated pesticides.

Dusts constitute the largest volume of pesticides used in the country, followed by emulsifiable concentrates (ECs), wettable powders (WPs) and granules. WP formulations are almost exclusively used in public health programmes.

Quality control facilities are fairly adequate in the case of manufacturers, especially of the large industrial firms, which maintain their own laboratories and have developed quality control systems. The quality control facilities of the small-scale formulators, however, need improvement, if not modernizing, in some cases.

As mentioned earlier, the PDPI has established the infrastructure and facilities necessary for the quality control of pesticides and has formulated training capsules to cater to the needs of the pesticide formulation industry. It has conducted three training programmes especially designed to benefit the small-scale formulators: Pesticide Formulation Development (18-22 February 1985), Pesticide Formulation Manufacture (18-22 March 1985), and Quality Control of Pesticide Formulations (15-19 April 1985). A fourth programme, a comprehensive course on Pesticide Formulation Technology was conducted from 28 October to 9 November 1985. In the latter two programmes, the author presented lectures on international specifications, gas chromatography and high pressure liquid chromatography.

RECOMMENDATIONS

1. If the PDPI Center is to make available its analytical services to the pesticide industry, it is imperative that the Analytical Development Group be constituted, with qualified experienced pesticide analysts.
2. Overseas trainings of one to two months duration should be incorporated in the present project document and proposed for six analysts of this group in laboratories where facilities for pesticide analysis and instrumentation exist.
3. Management should take advantage of the instrument training courses being offered by instrument manufacturers on a request basis to better prepare the staff in handling instrument problems.
4. Arrangements should be made for regular replenishment of chemicals and solvents to enable continuous laboratory operation.
5. The laboratory should follow a sample receiving protocol for the guidance of interested parties as per specimen presented.
6. Supplemental equipment, such as filtering systems, sample clarification kits, water purification system, air and hydrogen generators, which are essential to the proper functioning of the analytical equipment need to be purchased.
7. Spare parts, accessories and fittings should be available for smooth operation of the analytical instruments for at least two years. Budget should be allocated for this purpose.
8. In future ordering of analytical equipment, particular attention should be paid to the existing lot. Where satisfactory instrument performance is being obtained from a specific brand, it is advantageous to get a similar one as this would afford familiar operation, easier maintenance, and interchangeability of parts in case of breakdown.
9. A strong safety awareness programme should be implemented, with the usual laboratory equipment provided and fume hoods and fire extinguishers installed.

DISCUSSION

Training Programme

A training programme on Pesticide Formulation Technology was conducted by the PDPI for a group of 20 participants from the pesticide industry at the IFFCO Marketing Development Center, Gurgaon, Haryana from 28 October to 9 November 1985. The programme capsule is given in annex I. During this course, the author delivered three lectures on specifications for pesticides used in agriculture, gas liquid chromatography of pesticide formulations, and the practical aspects of high pressure liquid chromatography, and was involved in practical demonstrations on GLC and HPLC techniques. Abstracts of these lectures are given in annexes II to IV.

Analytical Development Group

The training programmes conducted by the PDPI during the year has brought the Center into focus of the pesticide industry. Numerous requests for assistance in the quality control aspect have been received from them that there is now felt a real need to create the analytical development group. PDPI wants to go full gear in making available its laboratory services to industry. Until this analytical group is created, there is no point in going even "first gear" on this plan. The first consideration is that industry should get accurate, reliable results in return.

However, a positive step has been taken with the deputation of M.L. Gupta to the unit. At present, Mr. Gupta is on a two-month training in pesticide analysis and the instrumentation involved therein in the author's laboratory in Manila, Philippines.

To be headed by a qualified analytical chemist, preferably a Ph.D. with sufficient experience in pesticide analysis, the responsibilities of this unit should include:

1. quality testing of pesticide products received from the pesticide industry (i.e., small-scale formulators)
2. testing of raw materials and ingredients of the formulation group

3. testing of products developed by the formulation group for stability, specifications, etc.
4. analysis of intermediates and by-products of the process development group
5. working out appropriate analytical systems (methods development)
6. generation of sufficiently pure analytical standards from technical materials

A proposed staffing component, the minimum adequate to effectively undertake the above responsibilities is as follows:

	Immediate	Future
Laboratory supervisor	1	-
Analytical chemist	2	2
Lab analyst/instrument operator	3	1
Laboratory aide	1	-

In time, in anticipation of more workload coming from industry, a full complement of ten is envisioned.

Mr. K. Soni and Ms. Mani, who are presently assigned to the instrument room, have been trained in the basics of instrument handling, operation and maintenance. Together with Mr. Gupta, they have worked with the author in instrument problem identification and isolation and in optimization ofoperating parameters for pesticide analysis. This contingency of two should provide the instrumental back-up for the analytical group.

Further Training for the Staff

It is admitted that the staff is still not prepared to handle instrument problems on their own. The professional attitude is somehow missing. This, plus the confidence that thorough instrument familiarization gives. It is, therefore, advisable to take advantage of the instrument training being offered by the manufacturers on a request basis. Such trainings may be requested of the Du Pont Company in Delaware, USA for HPLC and DTA, and the Perkin Elmer Corp. in Connecticut, USA for GLC, UV and IR Spectrophotometry. A regular instrumental course is being held by the Perkin Elmer Corp. in the United Kingdom, schedules of which need to be verified.

The author is a firm believer in the merits of an intensive residency training. It is in such a course that an individual's laboratory working habits/abilities are honed. Such a training should be proposed for members of the staff in a laboratory where facilities for pesticide analysis and instrumentation exist. This course, as suggested in the author's report of 22 May 1985 should cover such aspects as instrumental methods of pesticide analysis, basic gas chromatography, basic high pressure liquid chromatography, troubleshooting and maintenance, basic manipulations, and safety.

These overseas trainings of one to two months duration should be incorporated in the present project document and proposed for six analysts on a phased schedule.

Solvent Availability and Quality

The analytical laboratory staff must see to it that solvents are available for their own purposes and not rely on solvents borrowed from the other laboratories, the quality and purity of which they can never be sure of.

Non-availability of the required solvents, gases and glassware hampered work on several occasions. This constraint may be due to an observed local financial shortage in the Center. According to a worked out plan of activities, and recognizing the many intricacies of the ordering and purchasing processes, a quarter's requirement of solvents may be submitted and ordering schedules advanced accordingly so that solvent availability is ensured.

The quality and proper handling of these solvents are critical factors in any chromatographic system, particularly the HPLC. Realization of this by the lab staff will avoid the most frequently encountered problems, especially column blockage and high back pressure.

The use by the lab staff of reagent grade solvents and total disregard for filtration of solvents and samples have created such problems. Considerable time was spent in rejuvenating the HPLC system, regenerating columns, finding solutions to related problems.

Sample Receiving Protocol

The quality of the samples being introduced into any analytical instrument has a direct bearing on the operating life of that instrument. It has been observed that a number of samples being submitted for analysis either are "dirty", contain water, "highly colored", or just unacceptable (e.g. unknown powders on sheets of paper).

Samples received for instrumental analysis should be properly labelled or coded, in covered vials or containers, and with proper information given. This not only will serve the indexing purpose for ready reference and pinpoint individual responsibility but also will eliminate a lot of guesswork on the part of the analyst and save hours and money in wasted time. The data sheet given in annex V may serve as guide.

Supplemental Equipment, Spare Parts and Accessories

A list of supplemental equipment which is essential for the trouble-free operation of the analytical instruments is found in annex VI. Particularly for the HPLC, solvent cleaners, filtering systems, sample clarification kits, ultrasonic bath for solvent degassing, and a water purification system are needed to ensure quality solvents. Trace micro-particulates in the solvents can lead to problems such as premature seal failure, piston wear, or clogged leaky check valves.

The expensive HPLC column bears the brunt of impurities from samples, mobile phases, submicron particles from containers, etc. The result is a column with reduced chromatographic performance and/or high back pressure. This contamination problem may be minimized with the use of a proper guard column.

A stock of spare parts, accessories and fittings has to be kept to ensure ready availability when needed. In most cases, local representatives of instrument manufacturers do not keep a supply of these things. When the need arises as requests are received, they then order from the mother company. This process is time consuming and will add to the downtime of the equipment. A stock of spares should be available for smooth operation of the instruments for at least two years. A list of needed spares is found in annex VII.

The present staff in the instrument room should take interest in materials and replacement parts that are being ordered for the analytical equipment. Most managers are deep in administrative responsibilities to remember individual orders of materials which only the instrument people themselves will be using anyway. An example is the printed circuit board (PCB) for the display pattern of the HPLC. On installation by the local agent in May 1984, the PCB was found to be wrong. In October 1984, the replacement PCB was still unsuitable. Until now, the proper PCB has not been received.

In anticipation of more workload, another gas chromatograph is in the pipeline. It is suggested that another Perkin Elmer Sigma gas chromatograph equipped with a multidetection system be taken since the performance of the existing Perkin Elmer gas chromatograph has been satisfactory to date. For the operators, it would mean familiar operating controls, easier maintenance and parts could be interchanged freely in case of any breakdown.

Safety Awareness Programme

The need for this is underscored, more so now that an increase in lab activity is foreseen. People must be made to realize that the hazards from unchained gas cylinders, toxic vapor inhalation, volatile and flammable solvents, spillage from pesticide materials, etc., are real.

PDPI management must focus on a safety awareness programme to keep the personnel properly informed and trained in safe lab practices. However, no amount of information or training will be of value unless the individual practices safety throughout his work. What good are safety glasses, gloves, gowns if they are not worn? Cabinets have no eyes to lose nor lungs to be damaged. Fume hoods and fire extinguishers should be installed. HPLC solvents must be prepared in well-ventilated hoods to minimize buil-up of toxic vapors in the laboratory air. First aid kits have to be supplied.

Pure Analytical Standards

Several standards were brought over from the author's laboratory: dimethoate, methyl parathion, diazinon, phenthoate, dichlorvos, butachlor, monocrotophos, alpha-HCH, and beta-HCH.

Interactions

A list of contacts made during the mission visit is found in annex VIII.

PESTICIDE DEVELOPMENT PROGRAMME INDIA

Training Programme

on

PESTICIDE FORMULATION TECHNOLOGY

28 October - 9 Nov. 1985

Venue: IFFCO Marketing Development Centre
Gurgaon, Haryana

Demonstrations: PDPI Centre, HIL R&D Complex
Udyog Vihar, Gurgaon, Haryana

SCHEDULE

Monday, 28 October 1985

09.00 - 09.30	Registration of participants
09.30 - 11.00	Inaugural Session
11.30 - 12.30	Trends in Pesticide Formulation Design - Dr. S. K. Khetan
14.00 - 15.15	Emulsifiable concentrates, their development and manufacture - Dr. S. Mosinski/Dr. E. P. Yesodharan

Tuesday, 29 October 1985

09.30 - 10.45	Role of Surfactants in Pesticide Formulations
11.00 - 12.00	Dr. K. S. Narayan/Mr. B. B. Bagalkote
12.00 - 13.00	Dusts and wettable powder formulations, their characteristics and requirements - Dr. N. K. Pillai
14.15 - 17.00	Experimental Demonstrations (Emulsifiable concentrates and wettable powders - development)

Wednesday, 30 October 1985

09.30 - 10.30	Carriers and diluents for pesticide formulations - Dr. R. K. Khandal
10.45 - 11.45	Size reduction and blending techniques - Mr. S. Kumar
11.45 - 12.45	Colloid Chemistry and its relevance to pesticide formulations - Dr. S. K. Suri
14.00 - 17.00	Pilot plant demonstrations (various size reduction and blending equipments and methods of testing for physical characteristics of pesticide formulations)

Thursday, 31 October 1985

09.30 - 10.30	Granular formulations, their development and methods of manufacture - Dr. P. K. Ramdas
10.45 - 13.00	Speciality formulations i) Suspensions concentrate (flowables) ii) Water dispersible granules iii) Microemulsions Dr. S. Mosinski/Dr. E. P. Yesodharan
14.00 - 17.00	Experimental demonstrations (Granulation techniques and flowable formulations)

Friday, 1 November 1985

09.30 - 10.30	Controlled release formulations - Dr. P. K. Ramdas
10.45 - 11.45	Safety and Hygiene in pesticide formulation manufacture - Mr. V. N. Dutta/Dr. D. P. Nag
11.45 - 12.45	Packaging and Handling of pesticide formulations - Dr. P. V. Narayan
14.00 - 17.00	Experimental demonstrations (safety measures)

Saturday, 2 November 1985

09.30 - 10.30	Registration Requirements for Pesticide Formulations - Dr. K. D. Paharia
10.45 - 11.45	Factors responsible for the biological activity of pesticide formulations - Dr. B. P. Srivastava
11.45 - 12.45	Bioassay and field trails of pesticide formulations - Dr. N. R. Bhaeshwar/Dr. Y. P. Ramdev

Sunday, 3 November 1985

Excursion

Monday, 4 November 1985

09.30 - 10.30	Project feasibility studies for pesticide formulation plants - Dr. S. N. Nag
10.45 - 11.45	Plant layout for typical formulation plants - Mr. M. D. Muley
11.45 - 12.45	Costing of pesticide formulations - Mr. S. Kumar
14.00 - 17.00	Experimental demonstrations

Tuesday, 5 November 1985

09.30 - 10.30	Quality assurance of pesticide formulations - Dr. R. C. Gupta
10.45 - 12.45	Requirements of various types of pesticide formulations as per IS and International Specifications - Ms. Thelma Antazo/Mr. E. N. Sunder
12.15 - 13.00	Interaction of the participants with faculty members
14.00 - 17.00	Experimental demonstrations (Field Trials)

Wednesday, 6 November 1985

09.30 - 10.30	Methods of analysis for pesticide active materials - Chemical Methods - Dr. D. Sengupta
10.45 - 12.45	Spectroscopic methods of analysis - Theory and practice - Dr. A. S. N. Murthy/Dr. P. K. Ramdas
14.00 - 17.00	Experimental Demonstrations (Colorimetry, UV, IR)

Thursday, 7 November 1985

09.30 - 11.00	Methods of analysis of pesticide active material iii) Gas Chromatography - theory and practice - Dr. D. Sengupta/Ms. Thelma Antazo
11.15 - 13.15	High Performance Liquid chromatography - Theory and practice - Dr. Suresh Mohan/Ms. Thelma Antazo
14.00 - 17.00	Experimental demonstrations (Gas Chromatography)

Friday, 8 November 1985

09.30 - 10.30	Significance of bioassay in quality control of formulations - Dr. S. N. Deshmukh
10.45 - 11.45	Tower Biology - Dr. J. A. Barve
11.45 - 12.45	Group discussion (Futurology)
14.00 - 17.00	Experimental demonstrations (HPLC and chemical methods)

Saturday, 9 November 1985

09.30 - 10.30	Pesticide Application Equipments - Mr. S. L. Patel
10.45 - 12.00	Discussion and feed back from the participants
12.00 - 13.00	Concluding Session

EXHIBITIONS

1.	Size Reduction Equipments	29-30 October
2.	Surfactants	31 Oct. - 1 Nov.
3.	Packaging	2-3 November
4.	Instruments	5-8 November

OUR GUEST FACULTY

1.	Mr. B. B. Bagalkote	Dai-Ichi Karkaria (P) Ltd., Bombay	Oct. 29
2.	Dr. J. A. Barve	Bayer (I)Ltd., Bombay	Nov. 8
3.	Dr. R. C. Gupta	Directorate of Plant Protection, Faridabad	Nov. 5
4.	Mr. M. D. Muley	Sandoz India Ltd., Bombay	Nov. 4
5.	Dr. A. S. N. Murthy	Indian Institute of Technology, Delhi	Nov. 6
6.	Dr. S. N. Nag	Industrial Consultant, Calcutta	Nov. 4
7.	Dr. D. P. Nag	Directorate of Plant Protection, Cl , Faridabad	Nov. 1
8.	Dr. K. S. Narayan	Hindustan Lever Res. Centre, Bombay	Oct. 29
9.	Dr. P. V. Narayanan	Indian Institute of Packaging, Bombay	Nov. 1
10.	Mr. S. L. Patel	American Springs and Pressing Works, Bombay	Nov. 9
11.	Mr. Y. P. Pradhan	Rallis India, Bombay	Oct. 29
12.	Dr. B. P. Srivastava	Union Carbide R&D Centre, Bhopal	Nov. 2
13.	Mr. E. N. Sunder	Indian Standards Institute, New Delhi	Nov. 5
14.	Dr. S. K. Suri	IIT Delhi	Oct. 30

UNIDO Consultants

1.	Dr. Stefan Mosinski	Institute of Industrial Organic Chemistry, Warsaw, Poland	Oct. 28/31
2.	Ms. Thelma Antazo	Bureau of Plant Industry Manila, Philippines	Nov. 5/7

Annex II

SPECIFICATIONS FOR PESTICIDES USED IN AGRICULTURE

Abstract

In the field of pesticides, specifications have been set up as guideposts not only for manufacture, formulation and transport, but also as guarantees when these products are sold, distributed and used in international commerce.

Specifications for insecticides and for spraying and dusting apparatus were first published by the WHO in 1955 for compounds used to control insects of public health importance. A decade later, FAO came up with specifications for pesticides used in agriculture. FAO specifications differ from those of WHO in performance requirements and the content of active ingredient in formulations.

CIPAC and AOAC methods of analysis that have been collaboratively tested are adopted and incorporated in the specifications. A listing of physical and chemical properties, their aims, method availability and normal limits is given.

Tolerances for active ingredient content are included to account for differences encountered in manufacture and analysis.

Impurities are undesirable since they may induce decomposition of active ingredient, deterioration of packaging, give rise to phytotoxicity or lead to residues in food. Limits for known impurities are fixed and are absolute and no tolerance is permitted.

To meet an acceptable level of storage stability, stability tests need to be conducted.

Only general clauses on packing are given to allow for development of novel packing materials. Labels on containers must carry a clear warning of the hazards, with safe handling instructions and measures to be taken in case of accidental intoxication.

FAO issues three types of specifications: draft specifications, provisional specifications, and FAO specifications.

Specifications for each pesticide are published as small booklets.

Annex III

GAS LIQUID CHROMATOGRAPHY IN PESTICIDE FORMULATION ANALYSIS

Abstract

The paper presents the mechanics, instrumental aspects and techniques considered essential and practical for the analysis of pesticide formulations.

The two types of detectors commonly used in formulation analysis are the thermal conductivity and flame ionization detectors. The column is the heart of the gas chromatograph. The right choice of column material, liquid phase and support determines the efficiency of separation and quantitation that can be achieved with a gas chromatographic system.

If quantitative results are to be obtained, the factors that influence the response of the detector, such as variations in sample size, flow rate, and column and detector temperatures, must be controlled.

Possible areas where error can be introduced in the chromatographic tachnique are given. Sampling is a very important consideration.

The validity of any gas chromatographic method is dependent on the ability to quantitatively extract the pesticide from the sample matrix. Typical examples of sample preparation before gas chromatographic analysis are discussed.

Annex IV

A PRACTICAL APPROACH TO HIGH PRESSURE LIQUID CHROMATOGRAPHY

Abstract

Many of the disadvantages of column chromatography, such as low efficiency, long analysis time, non-reusable columns and poor quantitative reproducibility, have been resolved by high pressure liquid chromatography.

The basic equipment necessary for HPLC are: a pump to force the solvent over the stationary phase, an injection system to introduce the sample to the column, a column where the separation takes place, a detector and a recording device.

The paper focuses on critical points of the HPLC system like mobile phase prepation, filtering, degassing, sample preparation and filtration, and column selection.

To find optimum solutions to separation problems, an understanding of the effects of manipulating the different chromatographic aspects is essential. These manipulations and their effects are discussed.

Most classes of pesticides may be analyzed by HPLC. With certain pesticides, HPLC may be preferred for quantitation because it overcomes the limitations of gas chromatography: thermal breakdown and lack of volatility of compounds.

Annex V

SAMPLE DATA SHEET

Sample: _____ Date: _____

Request for Analysis:

GLC _____
HPLC _____
TLC _____
UV Spec _____
IR Spec _____
AA Spec _____
Others _____

Information on Sample:

_____
_____
_____

Suggested instrument operating parameters:

_____
_____
_____

Submitted by : _____

Analyst : _____

Approved: _____

Annex VI

SUPPLEMENTARY EQUIPMENT LISTING

1	Millipore's Milli-Q/Milli-RO water purification system
1	Millipore filter purification set
1	Millipore sample clarification kit
1	Ultrasonic bath, for solvent degassing
1	Hydrogen generator
1	Air generator
1	Computing integrator for gas chromatograph
1	Laboratory refrigerator with freezing compartment, explosion proof, self-defrosting

Annex VII

LIST OF NEEDED ACCESSORIES AND SPARES

For GLC:

Gas/liquid tight syringes, 50 ul capacity
Glass Luer Lock syringes, 10 cc
Glass Luer Lock syringes, 20 cc
Glass cclumns, empty, 3 mm i.d., 1 m, for Perkin Elmer Sigma 2 B gas chromatograph
Glass columns, empty, 3 mm i.d., 2 m, for same equipment
Packing materials for gc:
1.5% OV 17 on Chrom G HP 100/120 mesh
3% OV 101 on Chrom W 100/120 mesh
1.5% OV 17 / 1.95% QF 1
3% SE 30
Silanized glass wool
Column vibrator
High temperature septa for Perkin Elmer gas chromatograph
Assorted fittings: (sizes to be provided)
Graphite ferrules
Front ferrules
Back ferrules
Unions
Reducing Unions
Reducers, Adapters
Tees
Jets for FID, Perkin Elmer Sigma 2
Jets for NPD, same equipment
Injector fittings, same equipment
Detector fittings, same equipment

For HPLC:

Inlet check valves
Outlet check valves
Pistons
Injector seals
Injection port
Column frits, inlet and outlet
Seals for pistons, check valves

Filter syringe kit

Disposable filter units, 25 mm, 0.2 u porosity

Filter element, 0.5 u and washers

Filter, in-line, 0.5 u

Zorbax/TM/ column starter kit containing Sil, ODS, CN and C8 columns, 4.6 mm i.d., 25 cm

Supelguard Kits. 2 cm cartridge, 5 u

- LC-Si kit
- LC-8 kit
- LC-CN kit
- LC-18 kit

Replacement Supelguard columns for the above kits

Annex VIII

LIST OF CONTACTS MADE

UNDP/UNIDO	H. J. Nardi, Resident Representative, a.i.
	M. Kamal Hussein, SIDFA
	B. Sugavanam, Industrial Development Officer
	Sat Pal, Asst. Programme Officer
	S. Mosinski, UNIDO consultant in pesticide formulation
HIL	S.P. Dhua, Chairman and Managing Director
	K.D. Paharia, Consultant and Adviser
PDPI/HIL complex	Munni Lal, General Manager
	S.K. Khetan, R & D Manager, PDPI head
	N.K. Pillai, R & D Manager
	D. Nag, R & D Manager
	P.K. Ramdas, Group Leader, formulation
	D. Sengupta, Group Leader, process development
	V.N. Dutta, Group Leader, pilot plant
	S. Kumar, Group Leader, pilot plant
	N.R. Bhateshwar, Group Leader, bioassay and field trials
	E.P. Ramdev, Jr., Entomologist
	S. Mohan, Jr., Development Chemist
	R.K.Khandal, Clay Mineralogist
	S.N. Gupta, Scientific Assistant Senior
	Mukherjee, Sr. Scientific Assistant
	K.L. Soni, Instrument Supervisor
	S.N. Manee, Electrical Engineer
	Sarin, Lab Assistant
	M.L. Gupta, Lab Assistant
	M. Ahluwaliah, Administrative Officer
	T. Singh, Librarian