PN-AEJ-818

Consortium for International Crop Protection

4321 Hartwick Road, Suite 404, College Park, Maryland 20740 USA
Telephone: (301) 403-4223 ☐ Cable: CONSORTICP
Telex: 5106013963 ☐ FAX: (301) 403-4226

74505

EVALUATION OF PESTICIDE FORMULATION FACILITIES

Ivory Coast, Mali, Senegal, Kenya, Sudan

Leslie J. McWain

Formulation Consultant

Consortium for International Crop Protection

April 1987

INTEGRATED PEST MANAGEMENT AND ENVIRONMENTAL PROTECTION PROJECT

Contract No. DAN-4142-C-00-5122-00
Project No. 936-4142

Member Institutions: University of California, Cornell University, University of Florida, University of Hawaii, University of Illinois, University of Maryland, University of Miami, University of Minnesota, North Carolina State University, Oregon State University, University of Puerto Rico, Purdue University, Texas A & M University, United States Department of Agriculture

I N D E X

Introduction			i
Summary			iii
Conclusions			vii
Recommendation			ix
Specific Plant Visits			
Ivory Coast	I	Bayer Chemical	1
	II	Shell Chemical	7
	III	Ciba-Geigy	13
	IV	SOFACO	18
Mali	V	Sodema	24
	VI	OSPR	25
	VII	Inerts from Mali	32
Senegal	VIII	SSEDC	34
	IX	SPIA, Louga, Senegal	35
Kenya	X	May & Baker, Nairobi	40
	XI	Shell Chemical, Mombasa	41
	XII	Shell Chemical, Wad Medani	45
XIII Trip to Pesticide Storage Depot			49
Pictures of Pesticide Depot, Khartoum			53
XIV Trip to inspect portable incinerator			58
Pictures of portable incinerator			61
XV Contacts			65
XVI De-Briefing Report, Mali			67
XVII De-Briefing Report, Khartoum			71

INTRODUCTION

To assess the capabilities of formulation plants located in Ivory Coast, Mali, Senegal, Kenya and Sudan an inspection of eleven facilities was made between March 25, 1987 and April 14, 1987.

The purpose of this assessment is to determine the feasibility of pre-positioning technical pesticides only and formulating to local needs as required to curtail Grasshopper and Locust infestation in Sub-Saharan Africa as opposed to pre-positioning formulated pesticides to accomplish the same end result.

Inspection of sites was directed toward determining quantity and quality of production, expertise available in work force, material handling methods, worker safety and health awareness, availability of packaging supplies, logistics in receiving and storing technicals, inerts, solvents, emulsifiers, and distribution of finished product, effluent handling and disposal, general condition of machinery.

Further purpose to be served were to investigate the availability of inerts which could be used in formulation of dust pesticides, especially in Mali.

The scope was expanded in Washington, D.C., March 23, 1987 during briefing session with Carroll Collier, S & T Agriculture to investigate the possibility of chemically destroying left-over pesticides, or re-working them at the formulation plants visited. Further it was requested that a visit to inspect Shell Chemical's portable incinerator be made to determine if this would be a viable solution to destroying left-over pesticides.

SUMMARY

Of the twelve sites visited seven were, in my opinion, judged to be capable of formulating liquids while maintaining quality of production and meeting U.S. standards for worker health, safety and in handling effluent without environmental upset. Three of these sites are in Abidjan, Ivory Coast; one each in Mali, Senegal, Kenya and Sudan.

This makes pre-positioning of technicals and emulsifiers (if E.C. formulation are to be used) attractive because all other ingredients are locally available - i.e. solvents, packaging materials, transport and free schedule time in the plants.

The capacities available for formulating donor liquid pesticides for the remaining six months of 1987 are estimated at:

Ivory Coast	30,000 liters/day	150,000 liters/week
Mali	15,000 liters/day	75,000 liters/week
Senegal	15,000 liters/day	75,000 liters/week
Kenya	15,000 liters/day	75,000 liters/week
Sudan	15,000 liters/day	75,000 liters/week

About eight weeks lead time would be required to receive technicals from Europe or the U.S., and the same lead time for emulsifiers if E.C. formulations were to be used. Technicals would be received as ULV concentrates in 200 liter drums, then re-packaged in steel or plastic 5 liter containers, steel 30 liter pails whichever is best for field use. The ULV concentrates could be formulated into E.C. (emulsifiable concentrates) by adding emulsifiers and solvents.

To formulate dust there are four of the seven plants which satisfy the criteria, in my judgment; two are in Abidjan, Ivory Coast, one each in Mali and Senegal. There were no sites visited in Kenya or Sudan which I could recommend for dust formulation.

The estimated dust production capacities, and free time available for the remainder of 1987 are:

Ivory Coast	15 metric T/day	75 M.T./week
Mali	7 metric T/day	35 M.T./week
Senegal	7 metric T/day	35 M.T./week

Pre-positioning technicals for dust formulations would realize great savings because three of the four sites are now using inerts from Mali and Senegal (Ciba-Geigy's plant in Abidjan imports their inerts and technicals from Europe). The inerts

used for dust formulation is Kaoline (from Mali and Senegal), calcium carbonate (from Mali and Senegal), attapulgite (from Senegal), gypsum (from Senegal). Pesticide dust formulations can be made from liquid technicals (ULV) or from dust technicals, so pre-positioning ULV technicals can be used for both dust formulation, E.C. formulation or re-packaged into convenient field use sizes.

Granules were formulated at two of the plant sites; one in Abidjan, Ivory Coast using imported granules from Europe, the other in Senegal using screened marble/limestone granules which are sprayed with an adhesive then technicals added. The granules are then fed to a 10 meter long hot air kiln for drying at 100°C.

In trying to find out how much leftover pesticides are in storage brought estimates from 100 metric tons in Ivory Coast to over 200 tons in Mali, and an incomplete inventory in Sudan of nearly 200 tons. The pesticides cover all types from chlorinated organics to organo phosphates. Chemical treatment would not destroy all the pesticides and none of the formulation plants I visited were set up to use hot caustic (50°C. at PH 12.5 for several hours), and until contents were positively identified I would not recommend trying to destroy these pesticides chemically. Incineration is the only alternate that I am aware of.

Shell Chemical in Sudan has a portable incinerator that has been used as late as 1985 for incineration of pesticides. This incinerator is very much like a giant blow torch, and probably does not allow enough residence time to thoroughly destroy all pesticides. No off gas monitoring was done on the latest burn, so no firm data is available. Details, and pictures can be found under specifics of Sudan later in this report.

Prices for formulating liquids or powders were not made available to me, but all plant managers expressed willingness to negotiate prices when orders are ready to be placed.

CONCLUSIONS

Pre-positioning of technical pesticides in ULV form seems an economical way to be able to react to Grasshoppers and Locust infestation. By pre-positioning ULV technicals in 200 liter drums, the building block for any formulation is on hand. It can be used as is ULV, re-packaged in smaller units for field use; solvents can be added locally (kerosene, diesel fuel, Solvesso, etc.) to reduce active ingredient per liter content; the ULV technical can be used as emulsifiable concentrate by adding an emulsifier and solvents (emulsifiers would be imported at the same time as ULV technicals); ULV technicals can be sprayed on locally available inerts in blenders to make a dust concentration as low as 0.5% if needed; ULV technicals can be sprayed on bait carriers (rice hull - or other cereal hulls - ground maize cobs, ground nut shells, wheat chaff, etc.) in a blender and packaged in 40 kg. jute bags for distribution to the field.

The left over pesticides from year to year are much smaller in volume, and can be stored at the formulation plant for a nominal fee. This will prevent misuse by untrained individuals.

There is adequate formulating capacity of liquids in all five countries, and adequate dust formulating capacities in West

Africa to make pre-positioning a worthwhile endeavor.

The left-over pesticides from previous years, stored in poorly ventilated adobe type buildings or worse yet in the open can be most unhealthy to humans and animals in addition to the environmental impact. The volume can be estimated to exceed 600 metric tons, and may exceed 1,000 metric tons in the five countries visited.

RECOMMENDATION

I would recommend pre-positioning ULV liquid pesticide technicals, probably under contract with the formulation plants for storage and re-packaging or formulation and distribution to field drop off points with a maximum number of days lead time written into the contract for final delivery.

As one 200 liter drum of ULV has enough active ingredient to treat over 300 hectares the total on hand count of 200 liter drums at any one time could be held to as few as 200 drums per site, enough to treat over 60,000 hectares.

By contracting with the formulation plants, control is maintained by qualified personnel, an accurate accounting can be readily obtained, and priority of formulation or re-packaging would be enhanced.

Also ULV technicals can be received and inventoried "in bond" at plants until used, and if trans-shipped to another country no duty is paid. This strategy serves to reduce lead time by two to four weeks - the normal time to clear Customs at Abidjan. Other ports vary but two weeks is usually the minimum delay.

The left-over pesticides are greatly reduced in volume and are accurately counted in safe storage. The formulation plants I visited had much better ventilation in their warehouses, under roof, than the public depots had.

The inerts needed to make dust formulations will need to be stocked ahead of the rainy season due to open pit mining of the inerts and bad roads during rainy season. These inerts can be stocked at the formulation plants, under contract, and a price break may be achieved by providing formulation work during rainy season when these dust facilities normally run out inerts.

Due to large amounts of left-over pesticides, some in storage up to seven years, which include D.D.T., HCH, Dieldrin, Lindane and even sodium cyanide, I recommend a trial burn of some selected pesticides using the portable incinerator located at Shell Chemical Company's formulation plant in Sudan. During the test burn I would recommend testing of off gases to determine extent of destruction. Also during burn test it would be useful to know the flame temperature at different distances from the diffuser, for future use.

Abidjan, Ivory Coast

Bayer Formulation Plant:

Producing Granules:

Nemacur	10%	A.1. Fenamiphos received in 200 liter drums @ 70% A.1. from W. Germany.
Oftanol	10%	A.1. 1 Sophenphos received in 200 liter drums @ 80% A.1. from W. Germany.

Estimate one 250 kg. batch per hour = 2 metric tons/day.

There is one foreman, five hourly personnel and one Engineer.

Plant is estimated to run about 240 days a year, one half on granules, one half on powders.

Raw clay granules are imported from Spain, pre-sized to 30/60 mesh. Import about 200 metric tons clay granules per year. Import 70 drums of Fenamiphos and 65 drums of Isophenphos annually.

Equipment for granules consists of one tumbler, approx. 1 cubic meter; one pump to pump active ingredient from drum to charge tank; two pumps to pump from either of two charge tanks to spray liquid onto granules. Batch is harvested into plastic lined paper

bags, 25 kg. weighed and trimmed by hand on platform scale.

There is no storage tanks available. Drums of A.1. are stored in open so sun will keep liquid hot. There is one area set off from manufacturing area for storage of clay, paper bags, labels and other packaging material. This storage area is about 4 x 6 meters. The manufacturing area is about 6 x 20 meters. There is a finished goods warehouse, closed on three sides, and roofed, 4 x 6 meters.

All incoming materials are received via ship. This plant is about 8 kilometers from the docks at Abidjan. Local transport brings in material, about two trucks a month. The plant Engineer allows about three months lead time for arrival of materials from Europe.

The possibility of this plant shipping finished product up-country or exporting to another Sub-Saharan Africa country is too remote for consideration.

There is no quality control at this site. Periodic samples of finished material are air-mailed to Bayer, W. Germany for

analysis. The results are telexed back or phoned back.

This plant makes only Bayer products, and a limited range of those products. There are sales for all their production, so very little is held in their warehouse.

Granules are packaged in plastic-lined, paper bags holding 25 kg. These bags are pre-printed with instructions on use in French. All packaging materials is purchased from Finland and received by ship through port of Abidjan.

Bayer Plant Abidjan:

Powders:

No production at this time. The powder system runs about one half year when not running granules.

Powder production is estimated to be one 800 kg. batch in about 2½ hours = 2.5 metric tons a day.

The same personnel do either granules or powders.

Bayer Plant, Abidjan (cont.)

Estimate less than 1,000 hours a year on powders, 1,000 hours a year on granules.

Ground talc is received from Spain. Calcium carbonate and Kaolin received from Germany. Hydraqunone (for color) is received in 200 liter drums from W. Germany. Total imported annually for powder production is estimated to be: 4 drums Hydraqunone,200 liters each; 56 drums Phoxim as A.1. 80%, 200 liters each; about 180 tons of ground talc are imported annually from W. Germany; about 70 tons of Kaolin are imported annually from W. Germany; about 35 tons of calcium carbonate are imported annually from W. Germany. These imports are in addition to the imports required for granules.

The powder system consists of one Nautablender about 2 cubic meter capacity, a dust system exhausting through a small bag house for air conveying powders from a dump station to fill the Nautablender. Hydraqunone and Phoxim are pumped from drums to a spray bar in the top of the Nautablender where color and active ingredients are mixed with inerts. This batch is then harvested in 25 kg. plastic-lined, paper bags, pre-printed with

use instructions in French. These bags are imported from Finland. The bags are filled and trimmed by hand on the same scale as used for granules.

There are no storage tanks at this location.

All materials for dust and granules are received by ship through the port of Abidjan. Lead time for receiving materials imported from Europe runs three to four months from time order is placed.

The capacity of this plant is mostly used for formulation of Bayer granules and dust products. The work force is limited to a foreman and five hourly personnel, so timely production of any additional tonnage would be out of the question.

To formulate pesticides for Grasshopper or Locust control would, in my opinion, be beyond the capabilities of the personnel, and the plant.

There are some questions left unanswered by Bayer officials, which would preclude consideration for my recommendation, until answered.

Bayer Plant, Abidjan (cont.)

The questions left unanswered are:

1. What is done with 200 liter drums which are received and contained high active ingredient pesticides?

2. What is done with the granules, and dust production which was on the floor, several kilos of it?

3. Where are written instructions for manufacturing procedures?

4. What are the safety rules for handling the technicals, the granules, the dust?

There are other questions that were asked that went unanswered by the Engineer. The foreman may have had the answers, but his boss did not.

In my opinion this plant would have a difficult time trying to produce dust pesticides within the guidelines of good quality, minimum impact on the environment, and in a timely manner. It is my recommendation this plant not be considered for part of the U.S. donor pesticide program.

Abidjan, Ivory Coast

Shell Chemical Company Formulations Plant:

This plant formulates liquids only, and would not furnish price list nor give pricing.

The plant was in turnaround and were not formulating anything at the time we visited. They expected to start up the week following our visit. Did find over 100 drums of 200 liters each that had contained Alphamethrin and Cypermethrin technicals from Holland. These drums had been emptied, had holes punched in tops, bottoms, sides awaiting a scrap dealer to pick them up for scrap steel.

The estimated capacity is 20,000 liters per shift; normally run only one shift/day but do have supervision and personnel to operate two shifts five days a week if necessary. About 60% of their capacity (3,000,000 liters/year) are used on Shell insecticides, mostly in 0.5 liter up to 5 liter size for Ivory Coast domestic sales as Fastac and Ripcord.

The work force consists of seven degreed Engineers, including two Chemical Engineers, two Analytical Chemists, mechanical and

related disciplines. There are thirty hourly workers, and technicians, plus six supervisors. This plant also has a physician on call as an Industrial Hygienist, and to monitor worker health.

The plant operates about 48 weeks a year, shutting down for yearly vacations and maintenance needs.

Shell Chemical has developed a local source for emulsifiers that work in their products, which are mostly emulsifiable concentrates from 5% A.1. up to 25% A.1. (50-250 grams/liter). The solvents are obtained locally from Shell Refinery less than one km.away. The technicals are received from Europe in 200 liter drums and they import about 2,000 drums a year mostly Pryrethrins. There are a few drums of special solvent imported - N-Butanol, Cyclohevanone, but most of the solvents come from Shell Refinery.

There are five each mix vessels of 4,000 liters each. The technicals are chain hoisted to the charge duck and poured into the mix vessels, through an exhaust blower vented charge chute. Emulsifiers and solvents are added from storage tanks pumped through batch meters into either of the five mix

mix vessels. The empty technical drums are rinsed with solvent, and this mix added to the mix vessel then technical drums are taken to a diked storage area and holes punched into drums immediately.

There are four above ground storage tanks in a diked area. Each tank is about 40 cubic meters in size. One of these tanks is used for bulk storage of emulsifier. Re-supply of solvents into storage is only a matter of a few hours.

There are four finished product storage tanks, 4,000 liters each which gravity-feed the filling lines.

Shell's plant is located about 3 km. from the port of Abidjan, and less than 1 km. from Shell's Refinery. There is an ample supply of trucks, both bulk carriers and tractor/trailer types available in Abidjan. Shell leases trucks for their distribution on an as needed basis, and Mr. Harris, Director General of Shell Chimie, stated that transport trucks for incoming technicals, and distribution of finished product could be leased within the lead time needed to receive the technicals.

Mr. Harris estimates two to three weeks lead time, providing technicals can be received "in bond" to avoid Custom's delay.

The possibility of shipping finished pesticides up-country from Shell's facility is excellent. To shop to other Sub-Saharan countries may present a problem with Customs at the border of the country being entered. This could take a full day; for example, leaving Ivory Coast into Mali.

Shell Chemical facility has a full quality control lab for testing chemical components, as well as the physical qualities of the emulsions. This lab also checks workers' blood daily for CHI quality.

The lab is fully staffed and the log books of the lab were current with the latest production. They have a Gas Chromatagraph, a L.C., ovens, refrigerator, and even L.P. gas Bunson Burners.

There are written instructions at the formulation vessels for proper formulation procedures, step by step; there are first aid rules published, and safety requirements for each step of the operation. The same was true in the lab and the packaging area.

Shell Chemical, Abidjan, Ivory Coast (cont.)

The most frequently used container sizes are 0.5 liter, steel-inside varnished; one liter steel-inside varnished; 5 liter steel-inside varnished, plus some 5 liter plastic; 20 liter steel-inside varnished; 200 liter steel-inside varnished. Shell does not re-use containers. There are two fork lift trucks available for handling heavy loads. There is little manual labor above 15 kg. weight.

Labels are printed to Shell's requirements for their containers up to 200 liter size, where information is stenciled on drums. Labels could be applied to these steel drums if needed. All containers, labels, carton, glues are available locally in Abidjan and appear to be of first quality. Labels do contain first aid statements, in French, and user precautions, plus user instructions.

Shell Chimie formulation plant in Abidjan is well staffed, well trained, and in my opinion, as well run as most formulation plants in Europe or the U.S. They have the supply of solvents from a nearby refinery, can store raw materials and finished goods in well ventilated, organized warehouses. They are set

up to receive technicals, packaging materials, and distribute finished goods. I would recommend this plant for assembly of technical (ULV), formulation and distribution of finsihed goods.

At this time I cannot foresee any problems that Shell would have in any phase of pre-positioning to final distribution.

Abidjan, Ivory Coast

Ciba-Geigy Chemical:

During our visit to Ciba-Geigy they had just finished a liquid campaign formulating a liquid herbicide Dual 85% A.1. Methaxachlor imported from Switzerland in 200 liter drums. They have used 150 trailers (lift on/off) of 20,000 liter capacity to receive this technical. They have made a form of an E.C. using Cypermetrin and Profenopos imported from Europe and under license from ICI Chemical Company for use of their name Cymbush. The technicals are received in 200 liter drums, which had holes punched in tops, bottoms and sides after use. They were awaiting junk man to pick them up for scrap steel.

Also saw 200 liter drums of Diazinon 95% A.1., and Izosofos 95% A.1. in their storage inside a diked area.

Ciba-Geigy would give no price lists, but do have spare capacity. Their liquid plant is about 50% scheduled for one shift, and their newly installed dust formulation plant has not been used since installation in 1986.

Ciba-Geigy, Abidjan, Ivory Coast (cont.)

The liquid plant is capable of 10,000 liters per shift. Normally operate only one shift a day, 5 days a week, but have personnel and supervision to operate 2 shifts/day, 5 days/week. The annual production would be 2,500,000 liters a year for one shift, double for two shifts.

There are 20 hourly employees, six degreed members of management including an Analytical Chemist, two Chemical Engineers, management and two Mechanical Engineers. There are also technicians for lab and three supervisors.

The plant operates about 240 eight hour days/year, but have ability to operate two shifts a day.

Technicals and emulsifiers are brought in from Europe and the U.S. I estimate over 4,000 drums of 200 liters each are brought in. Solvents are purchased locally from Shell Refinery about 6 km. away.

Liquids:

There are four solvent tanks of 40 cubic meters each in a converted diked tank farm with pumps through batch meters to

each of four mix vessels:

3 mix vessels are agitated, 3,000 liters capacity each.

1 mix vessel, non-agitated, but with high velocity pump recirculating through mix nozzles in 1800 liter capacity.

1 finished product storage tank of 1800 liter capacity gravity feeds to either or all of four filling lines, automatic.

Powders:

1 Nautamixer, 2 cubic meter size, with hammer mill and screener for product sizing onto filling station for 25 kg. bags.

NOTE: This set up can be used for granule production by using spray bars in top of Nautamixer and removing hammers from hammer mill.

Capacity of powder system is 6 metric tons/shift.

Lead time from order placement to receipt of technicals or emulsifiers would be 2 months - almost half of which is clearing Customs @ Abidjan. Ciba-Geigy's plant is about 6 km. from the docks in Abidjan. Shipments are not a problem except the lead time. Ciba-Geigy hires trucks to freight in raw materials and distribute their finished goods to customers.

Ciba-Geigy, Abidjan, Ivory Coast (cont.)

Ciba-Geigy has a complete lab on site, with qualified personnel to run total quality checks. The lab log book was current with their latest completed run.

There are written safety rules, step by step instructions for each operation including warehouse, lab, packaging lines and formulations. They were getting the procedures out for Cymbus w/Profenofos which was their next product and taking up the Dual procedures while we were there.

Products are packaged in steel-varnished lined containers of 0.5 liters, 1 liter, 5 liter, 20 liter, and 200 liter sizes. The labels give user instructions for use, antidotes and disposal of containers in French. Containers, labels. cartons are purchased locally and are in good supply of good quality.

Technical drums are moved by fork truck, hoisted to charge duck level by electric hoist for liquids; hoisted by bucket elevator for powders and granules. The floors, buildings, grounds, warehouses were so clean a person could eat off them. Leakage or wastage is not a problem.

Ciba-Geigy, Abidjan, Ivory Coast (cont.)

In my opinion Ciba-Geigy's facility could furnish at least 3,000,000 liters/year of ULV or E.C. in any desirable size as soon as pipeline for emulsifiers and technicals could be started from Europe or U.S. Ciba-Geigy has worked with other major chemical companies in the past and I am certain they would make the necessary arrangements.

The only problem I can foresee is the lead time for getting the first shipment in of technicals and emulsifiers. Ciba-Geigy could, in my opinion, perform as well as any company in distribution of finished product, also to up-country or other Sub-Saharan countries.

Abidjan, Ivory Coast

Safaco Formulation Plant:

During our visit the granule system was not running. The liquid system was making Decis E.C. 5% A.1. Deltamethrin and the powder system was packaging Decis 2% in form fill 25 gram pouches.

An interesting note is a retail sales room in this plant where they sell Decis in every size and strength known, but sell almost every pesticide you could buy in K-Marts. They indicate that in the past they have formulated Malathion under agreement, and Sevin under agreement, both dusts and E.C.

Retail prices were available, but they would not give price lists.

The liquid lines have a capacity of 15,000 liters/shift. They can work 3 shifts, seven days if needed. This gives an annual capacity of nearly 5,000,000 liters. Their own production is about 4,000,000 liters/year. Powder capacity is three metric tons/shift, or 700 metric tons/year. Granule capacity is 2 tons/day or about 500 tons/year.

Safaco, Abidjan, Ivory Coast (cont.)

There are over sixty employees at this location, and they hire part time labor when needed to supplement their work force. The supervision is set up for three shifts with a Supervisor, an Engineer, a Chemist and 3 Lab technicians on each shift. This is in addition to a large office force and Production Manager, Plant Manager.

This plant operates about 300 days a year, and sometimes on 2 shifts. Total operating hours per year are between 2,500 and 3,000 hours.

Technicals and emulsifiers are imported from Europe and are in the range of 5,000 drums of 200 liters each. Solvents are purchased locally from Shell Refinery about 10 km. distant. The inert powders are imported from Mali; Kaolin, Talc. Imported from Senegal is Gypsum. The total import is over 650 metric tons of inerts. Granules are imported from Europe and will be 450 tons a year.

<u>Liquid vessels:</u>

5 agitated mix vessels. 1 @ 1500 liters, 2@ 2,500 liters, 2 @ 5,000 liters.

Safaco, Abidjan, Ivory Coast (cont.)

2 finished product hold tanks for gravity feed to automatic lines of 5,000 liters each.

Powder System:

2 each 2 cu. meter blenders.
1 form fill machine for powder size 9 grams - 200 grams.
1 25 kg. filling station.

Granule System:

1 tumbler - 1 cubic meter.
1 25 kg. filling station.

There are eight storage tanks for solvents.

1 @ 50,000 liters, underground.
4 @ 10,000 liters, underground.
1 @ 10,000 liters, above ground.
1 @ 5,000 liters, above ground.
1 @ 15,000 liters, above ground.

All tanks are connected to mix vessels by pumps through batch meters.

There are two dry storage warehouese, about 10 x 25 meters each. Well ventilated, well lighted, very neat and orderly.

Safaco, Abidjan, Ivory Coast (cont.)

Safaco plant is less than 10 km. from the docks at Abidjan. Transport is hired as needed for receiving raw materials from the docks; and hired as needed for distribution up-country. Dry powders are received from Mali in about two weeks, by trucks. Gypsum received from Senegal in about three weeks by ship. Lead time for technicals and emulsifiers from Europe is 1 to 2 months. Supply is kept on hand in diked storage. There is ample supply of trucks readily available in Abidjan.

Quality control is done in their lab which is completely equipped with G.C., L.C., all the necessary test equipment. There is an Analytical Chemist and technicians to staff the lab. The lab book was up to date with production when I examined it. There are safety rules for the lab, written instructions on test procedures available next to lab book. This plant is owned by Roussel Uclaf of France.

Liquids are packaged in 0.5 liter steel-varnished lined; 1 liter steel-varnish lined, 5 liter-varnish lined, 20 liter steel-varnish lined, 200 liter-varnished lined. Powders are packaged in 25 kg. paper bags-plastic coated, or plastic form fill pouches put into labeled boxes. Technical drums are rinsed

with solvent, then holes knocked in tops, bottoms and sides then sold for scrap. Containers are not re-used.

Drums are moved by fork lifts, hoisted to charge deck by electric hoist. Bags of inerts are hoisted to charge deck on pallets by fork truck. Wastage and leakage are not a problem. Production area very clean, well kept.

Labels are applied to all containers except 200 liter drums, which are stenciled. Labels contain user information, plus first aid instructions, cautions, and warns user to destroy container after use. All labels are printed in French.

In my opinion Safaco could formulate ULV, E.C., dust or granules for pre-positioning program. They could also help in distribution of formulated product up-country or to other Sub-Saharan countries. They have personnel and equipment to furnish quality product safety and with minimal environmental impact.

The only problem is lead time from Europe for receiving technicals and emulsifiers. Safaco has excess, unused capacity and the

Safaco, Abidjan, Ivory Coast (cont.)

ability to work 3 shifts a day.

One other problem may arise is receiving Talc, Kaolin from Mali once rainy season starts. The mines are open pit and probably cannot be worked during rainy season, plus roads may get to be a problem even for transport up-country.

Bamako, Mali

Sodema, Bamako, Mali:

This small facility now does mostly bar soap and powdered detergent formulation. They have done some powder pesticides formulation in the past. The plant manager would not show us his equipment, but did show us an agreement with Schering Chemical Co. of West Germany that stated he would be licensed to produce liquid and powdered pesticides for Schering after he built a new facility to Schering's specifications. The site has been purchased, Schering has the plans drawn up and equipment is to be placed on order in France in May, 1987.

The target date for start up of this new facility is November, 1987. This would be a possible second source for formulating pesticides in 1988, and a re-inspection next year may prove fruitful.

Bamako, Mali

Operation Protection des Semences et Recoltes:

The liquid facility was not operating while we were visiting the plant. The powder plant was producing Propoxur dust 2% A.1. from Propoxur technical powder 80% A.1. imported from Bayer, West Germany.

The price for producing this Propoxur was available to U.S.A.1.D. in Bamako, but was not made available to me.

This facility has formulated ULV and E.C. solutions using Profenofos A.1. 90%, Diazinon A.1. 95%, Malathion A.1 95%, Fenitrothion A.1. 95% as there were technical drums, full, containing these chemicals as well as special drums of solvent N-Butanol, Cyclohexanone.

The capacity of liquids should be 15,000 liters/day, five days a week, about 3,600,000 liters a year, about 40% of capacity presently scheduled.

The powder capacity is estimated at 3 metric tons/day, five days/ week, about 700 metric tons/year.

OSPR, Bamako, Mali (cont.)

NOTE: Recent powder production was Dieldrin 20%, Chlorodane 25% A.1, Propoxur W.P. 75% for packaging only.

The operations manager is a Chemical Engineer, there are several technicians reporting to him acting as supervision and running the lab. These technicians are the equivalent to junior college graduates. There are thirty-five hourly personnel. The office, and office personnel are about 11 km. from the plant site.

The plant operates about 240 days a year, one shift a day.

Liquids materials used are: Technicals and emulsifiers imported from Europe, solvents imported from Shell Refinery in Abidjan, Ivory Coast about 1,000 km. south of Bamako. This plant imports about 3,000 drums of 200 liters each of technicals and emulsifiers. They import about 750,000 liters of solvents from Abidjan, Ivory Coast.

Dust materials used: Technicals imported from Europe, about 400 drums per year either 200 liter for liquids, or 50 kg. drums for dry powder technicals. The inerts used are locally obtained,

about 500 tons of Kaolin from Yanfolia (about 250 km. south of Bamako) per year and 100-200 tons of calcium carbonate from northern Mali (about 450 km.). The mine for Kaolin in Yanfolia is operated by the same company that owns the formulation plant. The calcium carbonate is purchased from Bureau of Mines, Mali.

Liquid Equipment:

1 ea. 4,000 liter mix vessel, jacketed with hot water (50°C.) circulation in the jacket, agitated.

1 ea. 3,000 liter mix vessel, agitated.

1 ea. finished product storage tank, 4,000 liter. Gravity feed to automatic package lines.

1 ea. 3,000 liter product storage tank. Gravity feed to automatic package lines.

1 ea. hot water bath for heating technicals. Will hold 6 drums, 200 liters each. Water temperature is maintained at 50°C. with necessary pumps, electric hot water heater.

Powder Equipment:

1 ea. Nautamixer, 2 cubic meter, for pre-mix. Spray bar affixed. Harvest bag station.

1 ea. charge chute for inerts through hammer mill to sizing screener. Harvest bag station.

1 ea. mixing hopper for pre mix (@ about 20% A.1.) and ground inerts. Screw convey from mixing hopper to hammer mill into agitated harvest bin for finished product.

1 ea. feed hopper to small bag filling station (10 grams-1,000 grams) into plastic bags, the tops of bags hot sealed.

Storage, liquids:

There are seven storage tanks, two @ 25,000 liters each, two @ 20,000 liters, one @ 50,000 liters, two @ 15,000 liters. One of the smallest storage tanks is used for emulsifiers, the others used for different solvents, mostly Shell Solvesso A and kerosene. All tanks are pumped to either mix vessels through bath meters.

Technicals drums are stored in an open area inside fenced plant proper, as are special drums of solvent (N-Butanol, Cyclohexanone). NOTE: Empty technical drums are solvent washed, wash added to mix vessel, then tops and bottoms are removed, and all technical drums plus tops and bottoms put in "flame house" where L.P. gas flame heats metal to destroy residues. Steel is sold for scrap. The heat was enough to remove paint and no signs of residue observed.

OSPR, Bamako, Mali (cont.)

Dry Storage:

There were two roofed warehouses. One for raw materials was about 5 x 10 meters, poorly ventilated, the other was for finished goods, roofed with good ventilation 10 x 50 meters. Packaging supplies were kept in finished goods warehouse.

Receipt of technicals and emulsifiers are up to 2 months lead time from Europe, received through Abidjan, Ivory Coast about 1,000 km. away. Also solvents are received from Abidjan, all coming by truck. This takes a little less than a week, counting Customs delay at border. Transport is in ample supply both in Bamako and Abidjan.

Receipt of Kaolin from Yanfolia (250 km. south of Bamako) and calcium carbonate from northern Mali (500 km.) normally takes two to three days except during rainy season when mines are mostly shut down, because of open pit mining. The formulations plant can store about 100 metric tons of inerts in their dry raw material warehouse, but could easily store an additional 200-400 tons in their finished goods warehouse to carry production through the rainy season.

OSPR, Bamako, Mali (cont.)

OSPR does distribute some products up-country and could probably be useful in distribution of pre-positioned pesticides. As a matter of fact this plant just completed a 120 tons Propoxur 2% dust order for U.S.A.I.D. Bamako so the local office has details of distribution.

This plant has a complete formulations lab with a Chemical Engineer on site, plus qualified lab technicians. Their log book was up to date on the Propoxur 2% dust formulation production.

The written instructions available were in French, but seemed complete to the contract Engineer from U.S.A.I.D., Mr. Ian Mackay.

There were written instructions and safety rules for formulating and packaging the Propoxur 2% dust.

This plant makes product for Bayer Chemical, ICI, Rhone Poulene that were obvious.

The liquids are packaged in steel containers-inside varnished in standard sizes of 0.5 liter, 5 liter, 20 liter and 200 liter.

OSPR, Bamako, Mali (cont.)

Labels are affixed to all containers except 200 liter where product name and mixing instructions are stenciled on drum.

The bags used (25 kg. and 50 kg.) are plastic coated paper, pre-printed with instructions written in French. The small plastic bags are silk screened and the cartons are labeled. All packaging material are not re-used at this location.

The OSPR formulation plant is staffed, equipped and capable of formulating consistently good quality product of ULV, E.C. or powders pesticides and should, in my opinion, be considered for pre-positioning of pesticides.

The lead time for receiving technicals and emulsifiers are going to be 2 months, but ample truck transportation is available for receiving incoming raw materials and distributing finished goods. The largest problem will be for powder production; the locally available Kaolin and calcium carbonate must be stock-piled before rainy season when these inerts are not available. A minimum supply to keep the powder production satisfied for 4 months would be nearly 300 metric tons of inerts. If this pre-supply is done there should be no major barriers for pre-positioning.

Inerts from Mali:

The timing precluded visiting any mines while in Mali, but I did visit an Industrial Show, Mali style, which had exhibits from the Malian Bureau of Mines. They had displays of the minerals mined in Mali. These included:

Kaolin from Yanfolia

Phosphate from Bamako

Limestone

Gypsum

Marble

Cement

Calcium carbonate

All these minerals are mined in Mali, most of them in northern Mali.

The term talc is used in Mali and other ports of West Africa as a synonym for Kaolin. This creates a great deal of confusion as to which mineral is being referred to, but the Bureau of Mines had no knowledge of talc, only Kaolin.

I later visited Modibo Couibaly, Ingenieur Geologue, Direction Nationale de la Geologic et es Mines in Bamako. Mr. Couibaly was aware of the Kaolin mine at Yanfolia operated by OSPR formulation plant, but had no information on size of deposit or total reserve. He did state that a rather large deposit of Kaolin had been found at Boadie, about 180 km. northeast of Bamako and the Bureau of Mines was in the process of determining the quality and size of the reserve. Mr. Couibaly expected the mine to be operational within two years.

Dakar, Senegal

SSEDC Formulation Plant, Dakar, Senegal

The plant does not formulate liquids, powders only. Mostly is used for dry granule soap powders. The only equipment is a bucket elevator discharging into holding bin where plastic bags are filled by hand.

There is no blender, no lab, no quality control. This plant is a disaster, in my opinion.

SPIA, Louga, Senegal:

This formulation plant is located 180 km. northeast of Dakar. No price lists were made available.

The powder system was undergoing a maintenance overhaul, but the liquid system had just completed a run of Arrivok E.C. containing 10 gram/liter A.1. Cypermethrin and 50 grams/liter A.1. Isoxathion under agreement with FMC.

Other technical drums found, full, contained Propanile, Dimethoan, Ethyl Parathion, Malathion, Diazinon, Dyfonate. Empty technical drums had holes punched in tops and bottoms awaiting scrap dealer.

The estimated daily production is:

Liquids: 10,000 liters/shift, 3 shifts/day if needed = 30,000 liters/day.

Powders: 8 metric tons/shift, 3 shifts/day if needed = 24 tons/day.

Granules: 4 metric tons/shift, 3 shifts/day if needed = 12 tons/day

This plant is well staffed with an Analytical Chemist, two Mechanical Engineers, Plant Manager, Production Manager, Maintenance Manager, six foremen, 80 hourly personnel. They

quite frequently work three shifts a day, five days a week. The plant operates between 3,000-4,000 hours per year. About 60% of maximum time available on 5 day week.

All technicals and emulsifiers are imported from Europe through the port of Dakar, 180 km. away (about 3 hours by truck). This plant imports over 6,000 drums of 200 liters each of technicals and emulsifiers. Solvents are purchased from Shell Refinery in Dakar and received in bulk trucks, over 3,000,000 liters per year.

The powder inerts used are available locally in Senegal; calcium carbonate, Kaolin, Attapulgite and Attaclay. Also available is gypsum which this plant does not use. These inerts are readily available within 300 km. of plant, and nearly 5,000 metric tons per year are consumed.
NOTE: This plant grinds and packages Attapulgite for shipment to Stauffer Chemical Company in Europe.

Liquid Equipment:

one stainless steel, agitated mix vessel, 5,000 liters.

SPIA, Louga, Senegal (cont.)

3 ea. finished product tanks, 5,000 liters each, gravity feed to automatic package lines.

Hot water bath, holds 2 ea. 200 liter drums, circulating hot water @ 80°C.

Powder System:

Inerts are ground through a hammer mill to either of two blenders of 4 cubic meters each. From these blenders they are screw conveyed to Broyeur Ultrafine pin mill grinder, then pneumatically conveyed to an after blender of 4 cubic meter capacity, then through a bucket elevator to storage bins. 4 ea. @ 4 cubic meters. Packaging is done from these storage bins.

1 ea. 1.5 cubic meter Munson tumbler, necessary spray tank, pump to spray color and technical.

1 ea. bucket elevator to rotary kiln where granules are dried at 100°C. with hot air from diesel oil flame.

Discharge of kiln is to a 2 cubic meter storage vessel, and packaging occurs from this storage bin.

Also on site is a centifugal air compressor (oil free) about 1500 cu. ft. min. capacity. This plant is equipped with three very big dust collection systems through bag houses which keep the dust to a minimum. Very nice.

SPIA, Louga, Senegal (cont.)

Storage:

3 each 40,000 liter storage tanks, diked with concrete bottom. 1 tank used for fuel for kiln, the other two used for solvents. Raw material warehouse, very well ventilated, well lighted, can hold up to 2,000 metric tons of inerts. Finished goods and packaging supply warehouse 10 x 40 meters, well ventilated, well lighted.

All incoming and outgoing materials are by truck. There is an excellent road from Dakar, 180 km. away, and the road continues up to the mine country where the inerts are shipped from. Inerts are one week delivery after order, solvents are two days after order. Trucks are readily available in Louga and in Dakar.

All the sales and purchasing personnel are located in Dakar. This company does its own distribution of products up-country, and to a minor scale exports to Mali.

This plant is fully equipped with an air conditioned lab complete with written instructions on procedures, a G.C., and L.C., plus all the equipment necessary for physical testing of powders,

SPIA, Louga, Senegal (cont.)

granules and E.C. formulations. The lab log was up to date with production.

The containers used for liquids are steel-varnish lined in 0.5 liter, 1 liter, 5 liter, 20 liter and 200 liter sizes. All sizes except 200 liter are affixed with labels, the 200 liter is stenciled. The powders and granules are plastic lined paper, pre-printed, or plastic pouches put into cartons where labels are affixed. Instructions are in French, and give first aid information, user instructions and cautions against re-use of container.

In my opinion this plant is capable of furnishing high quality ULV, E.C., powders or granules for any pre-positioning of pesticides. This company seems well equipped to distribute to up-country or even to other Sub-Saharan countries.

The only reservations is availability of inerts during rainy season. Inerts would have to be stored before rains set in. The lead time is the same as with all other plants, up to 2 months for technicals and emulsifiers from Europe, one to two weeks for all other supplies which are available locally.

Nairobi, Kenya

May and Baker Formulation Plant:

This plant had recently been purchased by Rhone Poulenc and was undergoing a major renovation. At present there is no lab, no quality control, old, battered equipment which is to be replaced.

Until renovation is complete, and a lab in place I would not recommend use of this facility.

Mombasa, Kenya

Shell Chemical Plant, Mombasa, Kenya:

This plant was not operating (no business) when I visited. No price lists, available upon written request. The main product is Ripcord 5% E.C. A.1. Cypermethrin. This plant only formulates liquids.

The capacity of this plant is 10,000 liters/day, and is estimated to be 25% utilized.

The Plant Manager is a university graduate, with a total work force estimated at 18 people, including production manager.

This plant operates about 800-1000 hours/year, part of the time packaging brake fluid.

Technicals and emulsifiers are imported from Europe, and are estimated at about 350 drums of 200 liters each. The solvents are available at port of Mombasa about 1 km. away. Solvent consumption is estimated at 1,200,000 liters annually.

There are two agitated mix vessels of 4,500 liters each.

Shell Chemical, Mombasa, Kenya (cont.)

There are two finished product storage tanks of 4,500 liters each, gravity feed to automatic filling lines.

Storage of solvents is very large; total of 4,700,000 liters in 10 tanks: 2 tanks @ 1,000,000 liters each, 3 tanks @ 400,000 liters each, 5 tanks @ 300,000 liters each, in diked tank form complete with pumps to either mix vessel through batch meters.

While this plant is only 1 km. from port Mombasa, the lead time to receive an import license can be up to three months time, which is probably why this plant has very little business.

There are two very large warehouses, well ventilated, well arranged, each about 15 x 50 meters. Very neat.

As to shipping finished product up-country, Mombasa is over 600 km. away from Nairobi on a two lane highway. There is a single track R.R. but the trip to Nairobi is 14 hours. Shipping to other Sub-Saharan countries would be simple by ship. On shipping up-country by truck, there seems to be ample transport available in Mombasa and Nairobi.

Shell Chemical, Mombasa Kenya (cont.)

There is no lab at the plant site. The Government Lab SGS is located about 3 km. away and is used for all production.

There are written instructions available for safety rules and manufacturing steps.

Standard metal containers, varnish lined, are available in 0.5 liter, 1 liter, 5 liter, 20 liter, and 200 liter sizes on which labels are glued. Labels contain Shell standard warnings, first aid and user instructions, printed in Swahili and English. All supplies are available locally.

Fork lifts are vailable for lifting drums.

In my opinion this plant could provide quality product for pre-positioning pesticides but lead time is a real problem. In addition to the 2½ months transport time from Europe there is an additional 3 months for import license. The import license delay is the same for any incoming pesticides, but if orders were placed now it may be October before pesticides are ready for the field.

Shell Chemical, Mombasa, Kenya (cont.)

The only reservations I have other than lead time delay is the distance from Mombasa to end user in northern Kenya, which may be 1500 km. away over two lane highway. I do not know of any other alternates to this at this time.

Wad Medani, Sudan

Shell Chemical Company:

At the time of our visit there was no production taking place, and the plant was starting up on packaging brake fluid, and possibly liquid detergent. There were no price lists available.

The capacity of this plant in 200 liter drums would be about 20,000 liters, less if in 5 liter or 20 liter pails.

The plant manager is university trained, all others are not. There are about 18 employees at the plant.

The plant operates less than 1,000 hours/year due to lack of business. There were no technical drums on site that I could read the name off. A list supplied to me of some products made recently are:

Birlane 50% E.C. A.1. Chlorfenvinphos

Fastac Birlane ULV A.1. Alphamethrim, Chlorfenvinphos

Fastac Dimethate ULV A.1. Alphamethrim, Dimethate

Dieldrim 20% E.C. A.1. DDVP, Neopybuthrin

Dieldrin 3% Wood preservative.

Shell Chemical, Wad Medani, Sudan (cont.)

Unknown quantities of raw materials because of lack of business.

Mixing Equipment:

1 ea. stainless steel, agitated mix vessel, 1,430 liters.

2 ea. carbon steel, agitated mix vessels, 3,180 liters each.

1 ea. stainless steel finished product storage, 1,430 liters.

4 ea. carbon steel finished product storage, 3,180 liters each.

Storage:

1 ea. 1,000 cubic meter solvent storage

2 ea. 3,000 liter emulsifier storage tanks.

There is under roof (open sided) warehouse space of 10 x 20 meters, and a second 7 x 15 meters.

Wad Medani is 1,000 km. from Port Sudan the port of entry for incoming technicals and emulsifiers. There is a single track R.R. and a two lane highway. Solvents will come from Port Sudan. There appears to be an adequate supply of trucks available but this could present a problem.

Shell Chemical, Wad Medani, Sudan (cont.)

Finished product shipped up-country would be over two lane highway, and shipping to other Sub-Saharan countries would be questionable.

There is no lab at the plant site. Only physical tests can be made; density, emulsifiable qualities. Any testing would have to be air mailed to another country for verification of A.1 content. Probably air mailed to Europe from Kartoum.

The only size containers are 200 liters. Varnish coated inside, steel drums are available locally. Labeling would be stenciled.

The technical drums are all handled mechanically, either electric hoist or fork lift.

There are many shortcomings of this plant's ability to perform the needed service of pre-positioning. It is 1,000 km. from Port Sudan, but any imported pesticides are just as far away. There is no other formulating plant that I am aware of in Sudan, so choices are limited.

Shell Chemical, Wad Medani, Sudan (cont.)

In considering all alternatives I would have to recommend a minimal amount of pre-positioning pesticides be considered for this location, understanding that the only size container they can readily fill is 200 liter.

Khartoum, Sudan

Trip to Pesticide Depot, Khartoum, Sudan

I accompanied Dr. Munir Sabra of the PPD to inpsect a storage depot on the outskirts of Khartoum. The pictures I took will accompany this report in its final format.

There were pesticides in 5 liter cans that were stored so long in the weather the cartons had disappeared. Dr. Munir said this pile of about 7-10 thousand liters (1500-2000 cans) had been there seven years. The only information legible on the label was they were manufactured by Sandos Chemical of Basle, Switzerland.

There were pressurized bottles of Bromine gas, adjacent to empty 200 liter drums - unidentifiable - that had contained some chemicals. The ground was thoroughly saturated with the leacate from these leaking containers.

Insider the four storage buildings (one of which was used as a home for the two security guards), ventilation was nearly non existent. The dirt floors were covered with powdered pesticides that had been removed, and the pesticide scattered - in low concentration - in the desert area of northwest Sudan. The

four buildings were:

lea 15' x 15' approx. (This is the one the security guards used as home).
lea 15' x 30' approx. (One that powder had been removed from).
lea 12' x 15' approx. (A Rodancide was stored in here. Odor very bad).
lea 15' x 30' approx. (Locked. Key unavailable).
Open storage was 35' x 125'.

This depot was located in an area of small farms, and residences. There have been complaints from the neighbors concerning the odor, which was bad.

This depot is regarded by PPD as one of the worst in the Sudan. But even improvement of storage facilities by a magnitude of ten would be unacceptable by European or U.S. standards.

This situation is not unique to the Sudan. The same horror stories abound in each African country to some extent. The inventory of these depots are nearly complete in the Sudan and there is over two hundred tons identified so far.

Conclusions:

Due to the deplorable state of storage of left-over pesticides in Sudan, Ivory Coast, Mali, Senegal and to a lesser degree Kenya leads one to the conclusion that this is not acceptable environmentally or from human and animal health standards. Seven years is a long

time to store unused chemicals, in the open, adjacent to populated areas.

I would suggest a trial program to try to incinerate these liquids and powders, using old drums cut in half for the powders. This may require some air emission monitoring (available from EPA or outside consultant firms). It should be done in remote areas, and perhaps the residue ash broadcast over wide areas on top of the desert.

As one giant blow torch is available in the Sudan, this is the logical place to try the test program. They have the four necessary ingredients for success:

1. Need for action in disposal of left-over pesticides.
2. Machine ready for use, owned by a company (Shell) willing to undertake this venture.
3. Willingness of PPD to assist and co-operate in a trial project.
4. Aid officials who recognize the importance of developing a solution to the problem.

If the trial, with modifications as required, proves viable this could become a model for other African nations, with similar problems, to duplicate.

The trial might include some of the technical drums, which have been emptied but still contain some residue found at some of the

smaller pesticide plants.

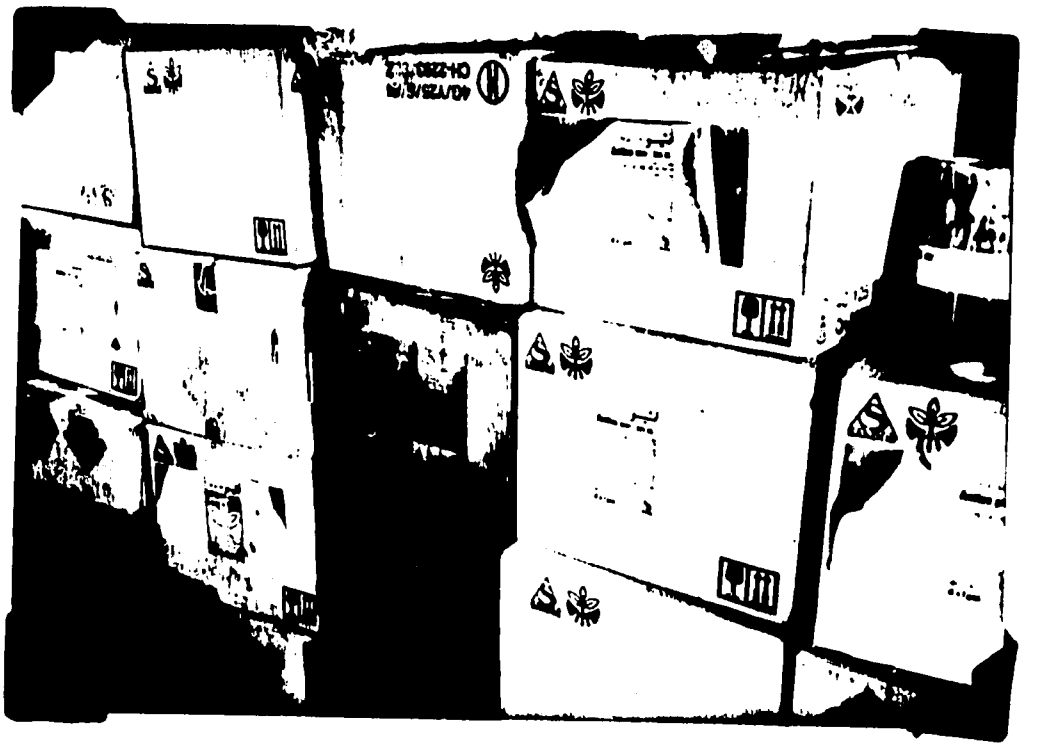
In discussions with Dr. Munir of PPD and Dr. Mackie of AID office Khartoum, both were agreeable to off gas testing. Shell indicated they would be agreeable if test results were verifiable and Shell had access to the results.

The alternates to trial incineration, as I see it, are:

1. Install necessary equipment in a fixed location to chemically destroy the active ingredient by using NAOH @ 50 degrees C at Ph 12.5+. This becomes somewhat difficult when dealing with E.C. solutions or W.P. concentrates due to emulsifiers. Acid can then be added to lower PH to acceptable level for discharge, after filtering.

2. Continue to store chemicals throughout the countryside in depots.

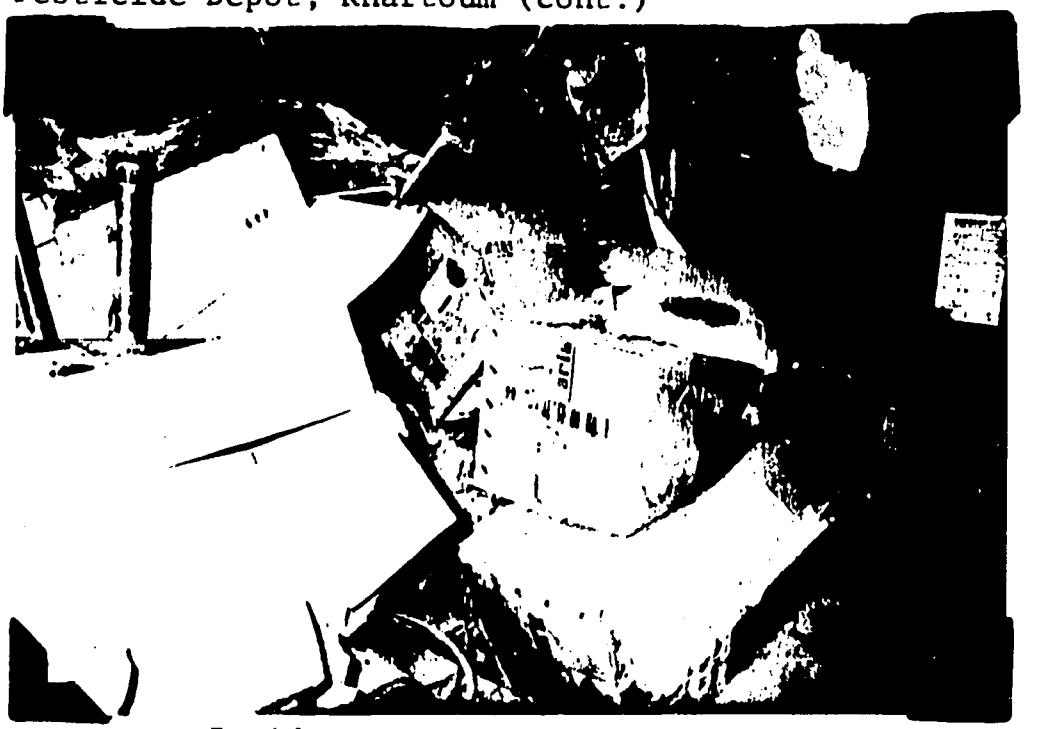
Photos of Pesticide Depot, Khartoum, Sudan



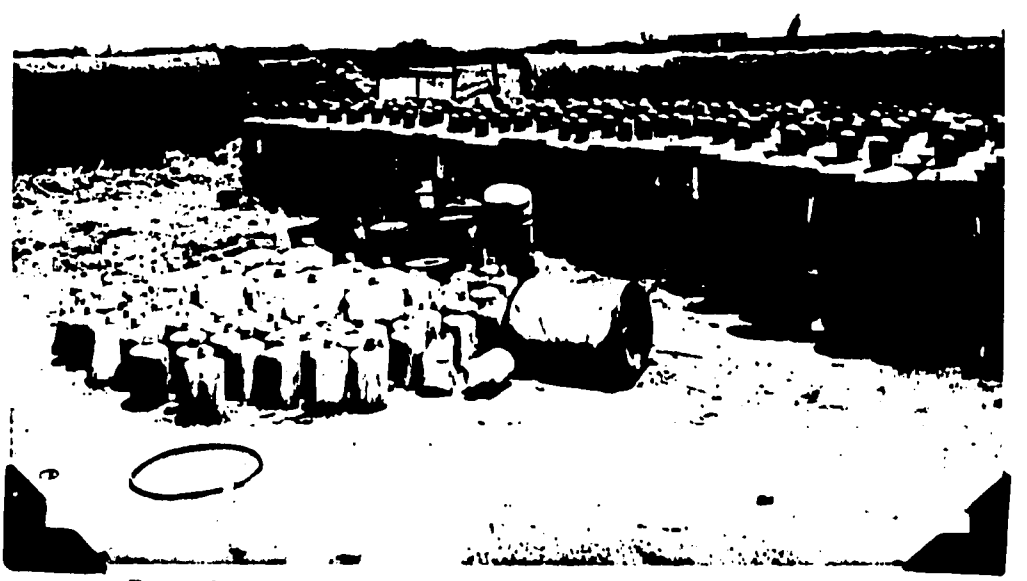
Sleeping quarters of security guards complete with leaking pesticides

Inside storage of pesticides and Rodancides

Pesticide Depot, Khartoum (cont.)



Inside storage of Pesticides/Rodancides



Bromine gas cylinder w/mixed pesticides.

Pesticide Depot, Khartoum (cont.)

outside storage - 7 years - pesticide

more outside storage, showing one warehouse

Pesticide Depot, Khartoum (cont.)

Outside storage showing neighboring housing.

Pesticide storage showing adjacent small farms.

Pesticide Depot, Khartoum, Sudan (cont.)

More outside pesticide storage.

Wad Medani, Sudan

Trip to inspect Portable Incinerator:

While at Shell facilities in Wad Medani Mr. Suliman Mudathir, Site Manager, showed me the WIBAU MD/801 incinerator, built in West Germany for destruction of pesticides in remote areas. The best overall description that comes immediately to mind is a giant blow torch.

The incinerator is mounted on a wishbone type, trailer-hitch fitted wheeled chassis similar to a welding machine, and can be towed behind a full sized pick-up truck.

Shell has a 75 KVA portable generator which accompanies this incinerator for power source. A smaller generator could suffice and be mounted on an enlarged chassis. I estimate that the connected and ancilliary equipment would draw less than 30 KVA.

The principle is quite simple, and the operation more suited to a good boiler operator than chemical operator.

1. The pilot light is L.P.G. fueled ignited by electric spark.

2. A flame eye that "sees" the pilot will allow starting sequence to begin.

3. Forced draft, two stage blower supplies air for combustion.

4. Two positive displacement pumps are fitted (one for diesel fuel; one for liquids to be burned). Each pump is fitted with a duplex suction strainer with fine mesh screen and should have magnets.

5. Diesel is fed into a burn orfice for atomization and fired by pilot and then through the air diffuser to a divergent fire clay cone to the atmosphere. Mr. Mudathir stated that flame is 6 to 8 meters in length and temperature is estimated at 1100-1400 degrees C.

6. Once flame pattern is set, then chemicals are put through atomizer nozzles in the same "ring" as the diesel fuel, permitting combustion of chemicals.

7. If flame out should occur the flame "eye" will shut off all fuel except L.P.G.

As the size of the flame will vary, and the capacity of the air blower was unknown, some rough assumptions can be made. The conclusion is the residance time of the chemicals at 1100-1400 degrees C will probably be 1-2 seconds. Not long enough for total destruction of chemicals but certainly an imporvement over storage for years with no known final resolution of the identified pesticides in storage.

By tilting the chassis, the flame can be directed to burn powders that are placed in split drums (drums split to provide two halves for holding powders). This would be a minimal destruction plan for

liquids and powder. This would be done in a remote area away from population

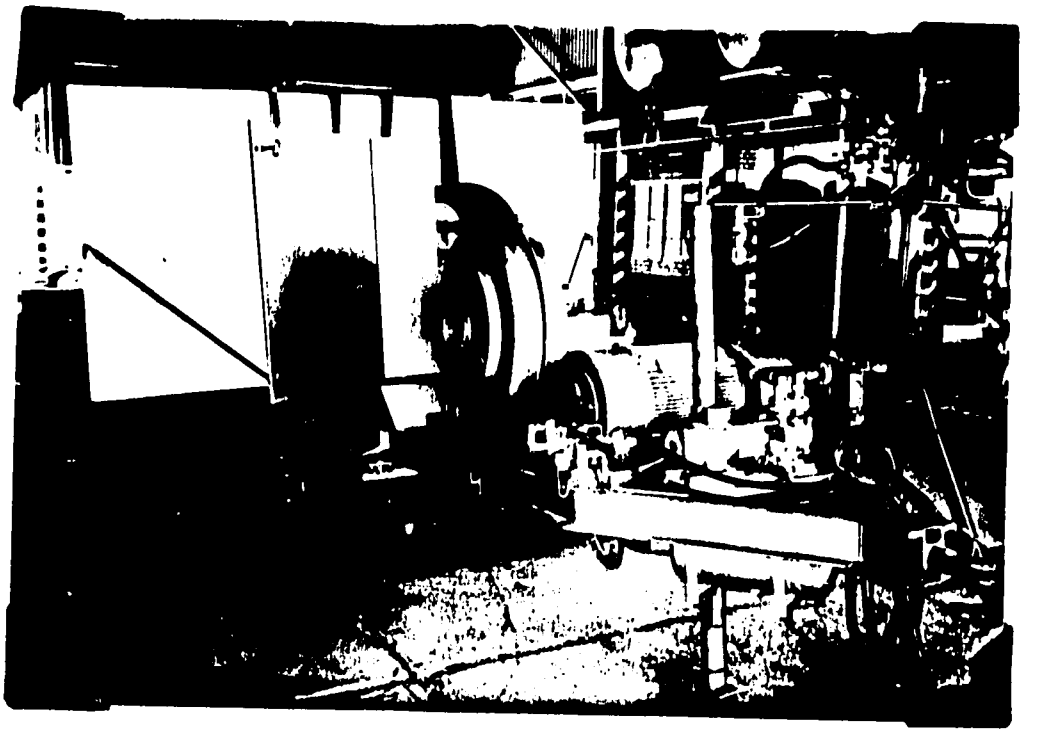
Drums that chemicals were stored in could be burned in the same manner.

Residence time could be increased by building a large brick structure to back the incinerator up to and have a stack at the opposite end. These brick burn houses could be located in remote areas and closed up when not in use.

Mr. Mudathir stated that the last burn did bring some complaints from residents living near by his plant due to black smoke and some odor. There is no evidence of any resulting health problems from this complaint.

The incinerator has a capacity of burning up to 3 tons of liquid chemicals a day. Less if water content is high.

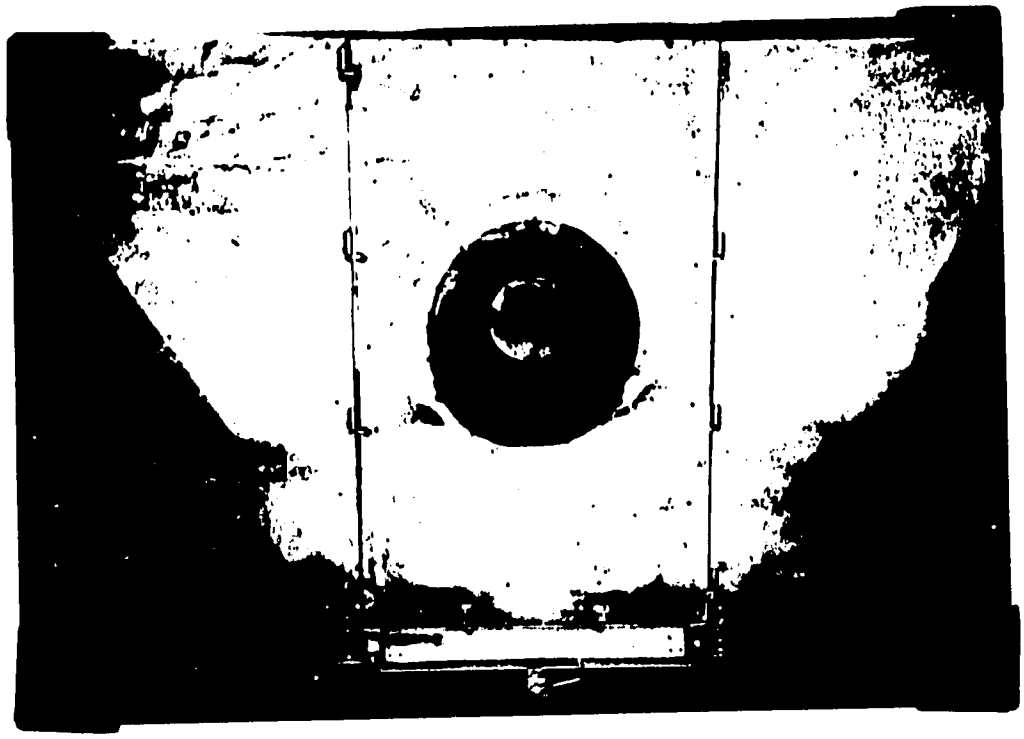
Wad Medani, Sudan, Incinerator pictures:



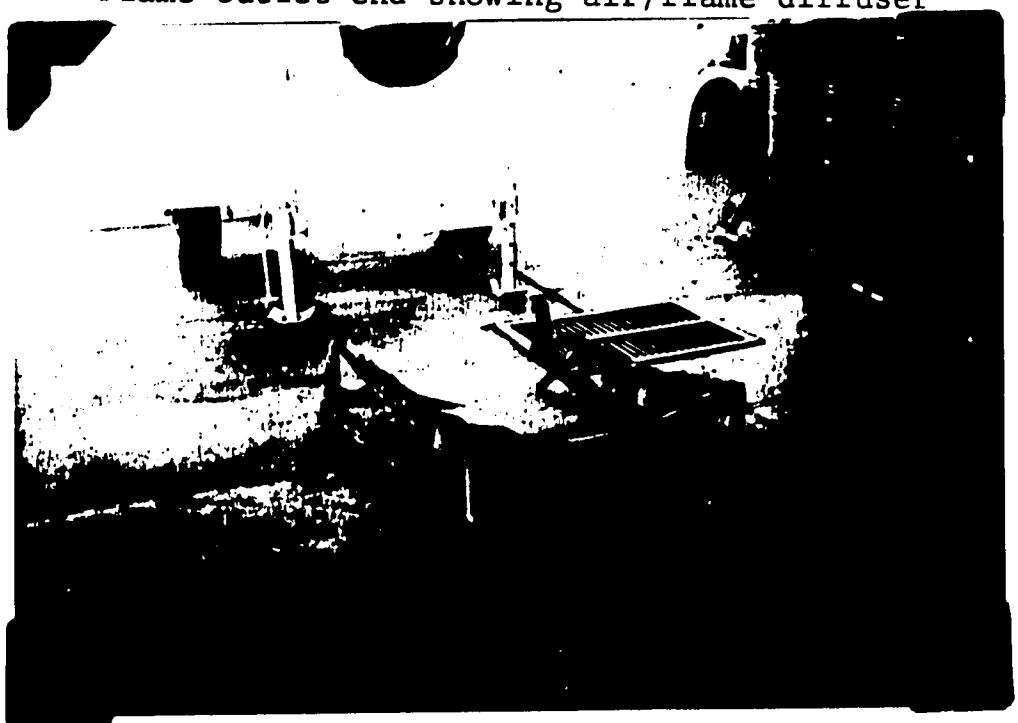
Front view of Incinerator

Mock-up of burn "ready to happen". Toxic waste and diesel fuel

Incinerator pictures (cont.)

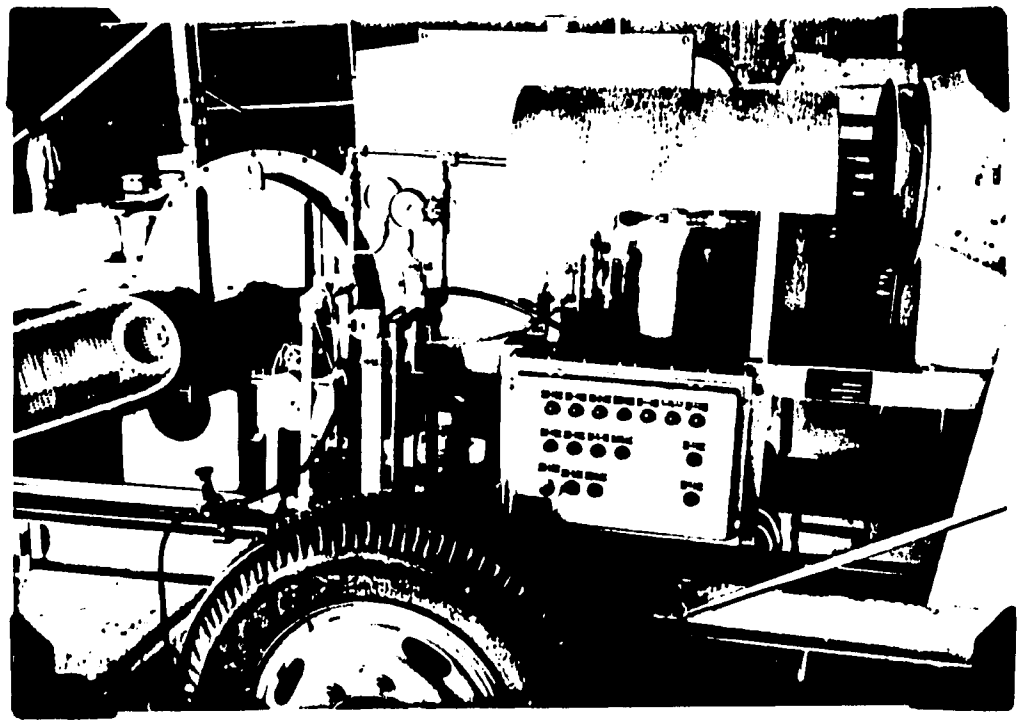


Flame outlet end showing air/flame diffuser

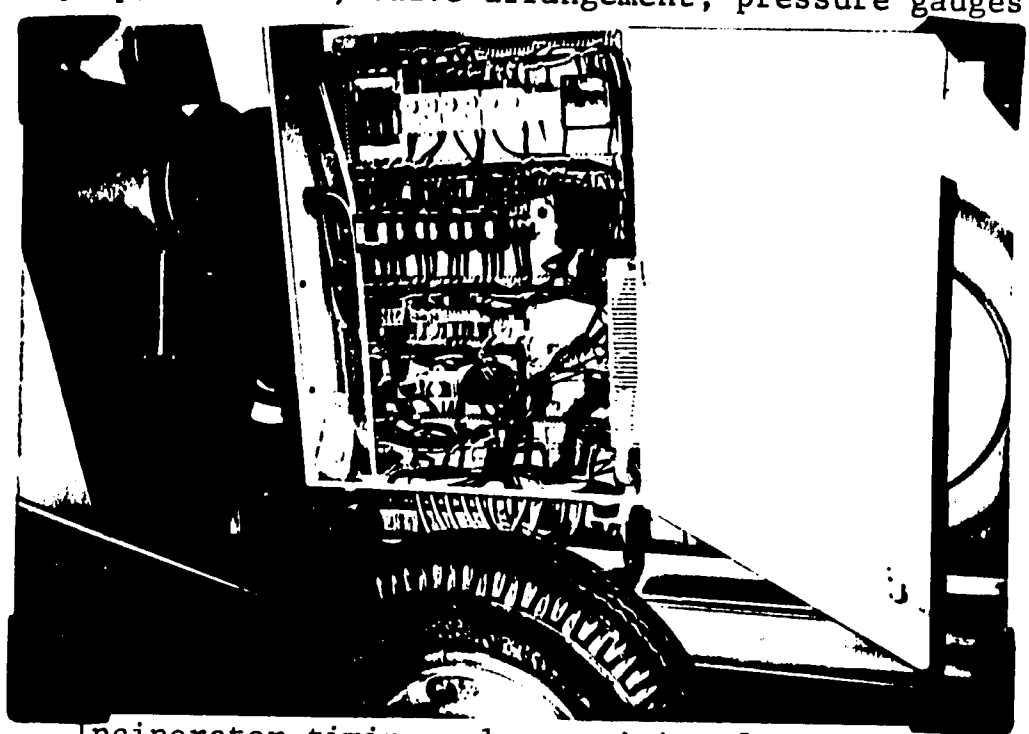


Steel pallet on which powdered insecticide in split drums rested during burn in 1985.

Incinerator pictures (cont.)

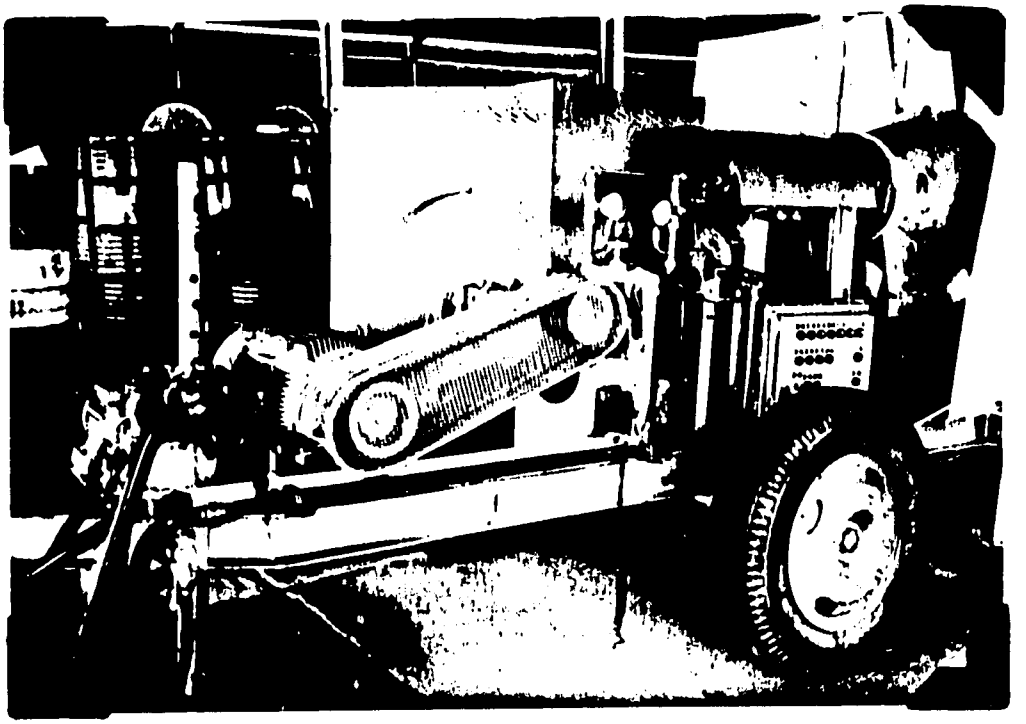


Incinerator control panel, forced draft blower, diesel fuel pump/strainers, valve arrangement, pressure gauges.



Incinerator timing relays, wiring for sequences.

Incinerator pictures (cont.)



Overview of Portable Incincerator.

CONTACTS

Mr. Harold Le Sieur, AFR/OEO, Washington, D.C.

Mr. Carl Caselton, Washington, D.C.

Ms. Bessie Boyd, Washington, D.C.

Mr. Carroll Collier, S & T, AG., Washington, D.C.

Mr. Ollie Bracey, Travel/Visa U.S.A.I.D., Washington, D.C.

Mr. John Lippold, AI.D. Abidjan, Ivory Coast

Mr. Jean-Claude Camaléonte, Ingénieur des Techniques Agricoles, Bayer Chemical, Abidjan, Ivory Coast.

Mr. Nicholas Harris, Directeur Général, Shell Chimie, Abidjan, Ivory Coast.

Mr. Joël Le Turioner, Responsable du Developpement Agricole, Shell Chimie, Abidjan, Ivory Coast.

Mr. Luc Gondo, Directeur Commercial Produits Phytosanitaires, Shell Chimie, Abidjan, Ivory Coast.

Mr. Michel Gesseau, Coordinateur Technico-Commercial, Ciba-Geigy Chemical, Abidjan, Ivory Coast.

Mr. Bernard Ravel, Délègue Général, SOFACO, Division of Roussel UCLAF, Abidjan, Ivory Coast.

Mr. Wilbur Thomas, Deputy Director, U.S.A.I.D., Bamako, Mali.

Mr. Rich Newbery/A00, Bamako, Mali.

Mr. Robert Boncy/GAG, BAmako, Mali.

Mr. Ian Mackay, Contract field representative, Bamako, Mali.

Mr. Modibo Coulibaly, Ingenieur Geologue, Direction Nationale de la Geologie et des Mines, Bamako, Mali.

Mr. Wilbur Thomas, Deputy Director U.S.A.I.D., Dakar, Senegal.

Contacts (cont.)

Dr. Ellis Huddleston, CICP consultant, Professor of Entomology, New Mexico State University.

Mr. John Gavin, CICP consultant.

Mr. Francis CAN, Research/Extension Coordinator, U.S.A.I.D., Dakar, Senegal.

Mr. Michel Mouthelie, Directeur Usine SPIA, Louga, Senegal.

Mr. Jean-Pierre M.B. Faye, Directeur Technico Commercial, Dakar, Senegal.

Mr. Leo Arao, U.S.A.I.D., Nairobi, Kenya.

Mr. C. A. Ghettuba, Production Manager, May and Baker Ltd., Nairobi, Kenya.

Mr. Charles Okuthe, Plant Manager, Shell Chemical, Mombasa, Kenya.

Mr. Sharon A. Fee, AG. Development Office, U.S.A.I.D., Sudan.

Dr. Anita Mackie, G.D.O., U.S.A.I.D., Khartoum, Sudan.

Dr. Munir Gabra, Plant Protection Department, Khartoum, Sudan.

Suliman Mudathir, Manager Chemicals Plant, Medani-Maringan, Sudan.

Dr. Gudron Hartig Huden, U.S.A.I.D., Washington, D.C.

LESLIE MCWAIN'S TRIP REPORT
BAMAKO, MALI:
(March 28, April 1, 1987)

Contacts: Wilbur Thomas, Deputy Director
Rich Newberg/ADO
Robert Boncy/GAG
Ian Mackay, Contract Field Rep.

I. **FORMULATION PLANT**
"Operation Protection des Semences et Recoltes".
A. Can formulate liquids and powders - no granules

1. Liquids: formulation
1 ea. 4,000l mix vessel, agitated with heat jacket served by hot water (50°C). Discharges into 8,000l holding tank until analysis is complete, then pumped into 4,000l gravity tank for packaging.

1 ea. 3,000l mix vessel, agitated - no heat jacket. Used for supplemental formulation capacity. Pumps to 3,500l square gravity tank for packaging.

2. Liquid: Packaging
Two manual packaging lines that can fill metal or plastic containers in sizes 1/2l up to 5l; should be able to fill 25l or 200l steel drums as well.

Note: All packaging equipment is available locally: plastic bottles, caps, labels, cartons, up to 25 liters. Metal cans up to 1 liter with rolled tops. Supply of packaging material not a constraint.

3. Liquid Auxilliary Equipment:
1 ea water bath for up to 6 ea. 200 liter drums of technicals. Hot water bath is circulated through electric heater and can maintain 50°C (same system as used on mix vessel heat jacket) with small pump.

7 each solvent/emulsifier storage tanks, total storage capacity 170,000 liters.

Note: These supplies, i.e. technicals, solvents, and emulsifiers are normally supplied by drum (for technicals and emulsifiers) and solvent bulk truck from Abidjan. Delivery notice one week for solvent truck; 6 weeks to 2 months for technical drums and emulsifiers from Europe br surface carrier. Shorter lead time possible with delivery by air.

4. Liquid Capacity:

Starting with sufficient technicals (2 month lead time, minimum) and ongoing delivery of bulk solvents (one week minimum) plant should be able to sustain 20,000 liters/day/5days a week of good quality finished product.

Note: Liquid technicals observed:

- Profenofos
- Diazinon
- Malathion
- Fenitrothion

5. Effluent disposal:

A. Drums are rinsed with solvent, after heating and gravity dumping into mix vessels. Then sodium bicarbonate powder and water are added to "sweeten" drums. Water rinsate is dumped into 3 ea concrete holding tank (40m3, underground). When about 180 drums have been "sweetened" an additional amount of sodium bicarbonate is added to tank. A local disposal company then sends a truck to pick up effluent and haul to rural dump site.

Note: This is similar disposal method used by Shell, Ciba-Geigy, Safaco formulation plant in Abidjan.

Technical drums, after dumping rinsate, have tops and bottoms cut out with hammer and chisel, them drums plus tops and bottoms are subjected to profane flame in a closed room before disposal for scrap steel.

Note: About 300-400 drums were stored adjacent to burning room and all had been subjected to enough heat to remove all exterior paint. No visible signs of material inside drums or on tops or bottoms.

II. POWDER PRODUCTION:

1. Inert material (Kaolin from Mali) is received in plastic coated jute bags of 40kg each, then hoisted (electric) to dump station, through one of two small hammer mills, then gravity feed to a sizing screener which harvests 50-60U sized particles. Over and under sized materials are disposed of. This clay is bagged into same bags as raw kaolin, then part of it taken to a Nauta type mixer where kaolin and propoxur 80% from BAYER/Germany is added to make a 20% A.I. pre-mix, which is caught out in bags, added into a hopper with additional pre-ground talc to make final 2% A.I. powder. This final powder is then ground through another hammer mill to final 15u size particles. Again this powder is packaged into 25kg or 40kg plastic coated bags for use.

Note: Product can be taken (via bag) to small powder packaging room where facilities exist to package in plastic bags, top heat sealed after filling to 200 gram weight or less. Also when "pre-mix" is added to additional kaolin, a liquid color is sprayed onto final formulation (in this case red). This allows personnel applying dust to tell where they have applied dust.

2. Other powders observed that had been formulated/packaged.
   - 1. Dieldrine 20%
   - 2. Chlorothalone 25%
   - 3. Propoxur 75% wettable powder for packaging

III. **SAFETY AND PERSONNEL**

A. The personnel handling product containing PROPOXUR were wearing long sleeved cokeralls, rubber boots, gloves, dust masks.

B. Shower and rest room facilities were readily available.

C. No safety eye wash stations, or safety showers were seen.

D. Laboratory was equipped with functioning gas chromatograph, liquid chromatograh, and physical test equipment. Qualified Lab technician reporting to a Chemical Engineer were in evidence.

E. Housekeeping in liquid area excellent. Poor in powder area.

F. Unloading of tank raw material from 20 ton truck was done bag by bag by hand.

G. All other operations done with hoists (electric), or lift truck (PROPOXUR).

H. Equipment was fairly new and looked in good working order.

The capacity is available at this plant to make high quality, consistently good powders of about 3 tons a day/5 days a week rate.

The only constraints are lack of technicals, and lack of kaolin during rainy season (unless supply could be warehoused ahead of time).

IV.. **KAOLIN FROM MALI:** Conference with Modibo COULIBALY, Ingenieur geologue, Direction Nationale de la Geologie et des Mines, B.P. 223, BAMAKO, (Mali).

1. YANFOLILA (about 250km south of Bamako) paved road, but bad. Probably 5 hour trip in dry season. Operated by OPSR (formulation plant owners) who state "adequate supply". Cannot be mined or transported during rainy season (mid April until October). Deposit reserve unknown.

Note: I have sample of raw material and a sample after grinding to 50-60 u

2. BOKDIE (about 180km Northeast of Bamako) good paved road. Ministry of Mines is prospecting this deposit. No details yet available on quantit, or quality.

Note: Good possibility for future use.

SUMMARY: The OFSR formulation plant is staffed, equipped and capable of formulating/packaging good, consistent quality powders and liquids in an evironmentally sound posture (except for disposal of rinsate into bush area as noted).

Constraints are lead times required for technicals, emulsifiers and solvents; plus the availability of kaolin during rainy season. With a minimum of pre-planning these constraints can be overcome.

The possibility of this plant being able to re-work or safety dispose of old, surplus pesticides (eg. dieldrine, DDT, etc...) is very remote. No such facilities were observed.

To meet the need of 600 tons metric of powdered pesticide would require this plant's full production time for a year.

BY MR. LESLIE MCWAIN

TRIP REPORT, CONCLUSIONS, RECOMMENDATIONS ON VISIT TO SHELL COMPANY FACILITIES AT WAD MEDANI

KHARTOUM, SUDAN

APRIL 12, 1987

I. Formulating Facilities:
1. Storage facilities, bulk.

A) 1 each 1,000 M^3 solvent storage tank, properly vented inside concainment dike, carbon steel.

B) Two each emulsifier horizantal storage tanks, 3,000 liters each, carbon steel.

C) Four each horizontal formulated product storage tanks, 3,180 liter, carbon steel.

D) One each stainless steel horizontal product storage tank, 1,430 liters.

II. Mixing Facilities:

A) 1 each stainless steel agitated mix vessel, 1,430 liters.

B) 2 each carbon steel agitated mix vessels, 3,180 liters

C) Necessary pumps from solvent storage, emulsifier storage to all three mix vessels through batch meters.

D) Technicals can be added through man-holes into mix vessels by lifting drums to charge deck by forklift (2 available) then tipping drums by hand. Or an alternate method (not normally used) could be by pumping with on site available electric drum pumps.

E) Formulated material sample is drawn and tested for emulsifiable characteristics (pass/fail); flash point; specific gravity. No test equipment available for determining active ingredient.

III. Packaging Equipment:

A) 2 each 200 liters drum filling stations gravity fed from any of the five formulated product storage tanks.

B) Drums are filled on weight cells to proper weight, free fall into drum.

C) Drums are sealed and rolled on roller bed conveyors then taken to storage.

IV. Supplies:

A) Solvents, emulsifiers both can be received in bulk by tanker truck or R. R. car from Port Sudan, approximately 1000 km away over a two lane paved road, or single track Sudan RR.

B) Technicals received in drums.

C) Empty steel containers, 200 liters can be purchased locally or imported.

D) Product identification is spray painted on drums using stencil and paint sprayers.

V. Capacity:

A) No pesticide production now taking place. Some liquid soap detergent is being formulated, and some brake fluid being packaged.

B) Production should be able to sustain 20,000 liters/day in 200 liter drums of E.C. or ULV.

C) Quality control for accurate active ingredient content would have to be done elsewhere, perhaps Europe. This could incur a 3-5 delay in shipment. Shell has sufficient warehouse space, under roof, to store this volume on site.

Note:
There is a Sudan Government Laboratory within 3 Km of Shell's facility but is unusable. This facility was donor built in 1984, then the test equipment was donor purchased. Before equipment could be installed the building walls, roof and flooring has settled and made the building marginally unsafe so that equipment is not yet installed.

Conclusion:
Shell has formulating capacity, personnel and experience to formulate and package upwards of 6,000,000 liters annually of liquid pesticides in a safe, competant package. Testing for active ingredient would have to be done elsewhere, but this is possible with a week delay, maximum, during which time product can be warehoused awaiting final release.

Economically it is probably cheaper to import formulated material, duty free, than pay duty on all required imported solvents, emulsifiers containers and technicals. The drawback to this is storage of right pesticide (ie. E.C or ULV) to react to a specific circumstance.

If ULV is needed quickly Shell could have solvent in their storage tanks and technicals or hand to fill orders quickly. If E.C. was required Shell also could react very quickly with their solvent storage and emulisifer storage. Straight import of formulated pesticide may require stocking both E.C. and ULV in sufficent quantiies for either case use.

Local storage of technicals, solvents and emulsifers is the preferred method for quick reaction to either case and would greatly reduce carry-over inventory of formulated pesticides which are a large problem.

Report on Field Use or Portable Incinerator

While at Shell facilities in Wad Medani Mr. Suliman Mudathir, Site Manager, showed me the WIBAU MD/801 incinerator, built in West Germany for destruction of pesticides in remote areas. The best overall description that comes immediately to mind is a giant blow torch.

This incinerator is mounted on a wishbone type, trailer-hitch fitted wheeled chasis similar to a welding machine, and can be towed behind a full sized pick-up truck.

Shell has a 75 KVA portable generator which accompanies this incinerator for power source. A smaller generator could suffice and be mounted on an enlarged chassis. I estimate that the connected and ancilliary equipment would draw less than 30 KVA.

The principle is quite simple, and the operation more suited to a good boiler operator than chemical operator.

1. The pilot light is L.P.G. fueled ignited by electric spark.
2. A flame eye that "sees" the pilot will allow starting sequence to begin.
3. Forced draft, two stage blower supplies air for combustion.
4. Two positive displacement pumps are fitted (one for diesel fuel; one for liquids to be burned). Each pump is fitted with a duplex suction strainer with fine mush screen and should have magnets.
5. Diesel is fed into a burn orfice for atomization and fired by pilot and then through the air diffuser to a divergent fire clay cone to the atmosphere. Mr. Mudathir stated that flame is 6 to 8 meters in length and temperature is estimated at 1100-1400 degrees C.

6. Once flame pattern is set, then chemicals are put through atomizer nozzles in the same "ring" as the diesel fuel, permitting combustion of chemicals.
7. If flame out should occur the flame "eye" will shut off all fuel except L.P.G.

As the size of the flame will vary, and the capacity of the air blower was unknown, some rough assumptions can be made. The conclusion is the residance time of the chemicals at 1100-1400 degress C will probably be 1-2 seconds. Not long enough for total destruction of chemicals but certainly an improvement over storage for years with no known final resolution of the identified pesticides in storage.

By tilting the chassis, the flame can be directed to burn powders that are placed in split drums (drums split to provide two halves fo holding powders). This would be a minimal destruction plan for liquids and powder. This would be done in a remote area away from population.

Drums that chemicals were stored in could be burned in the same manner.

Residence time could be increased by building a large brick structure to back the incinerator up to and have a stack at the opposite end. These brick burn houses could be located in remote areas and closed up when not in use.

Mr. Mudathir stated that the last burn did bring some complaints from residents living near by his plant due to black smoke and some odor. There is no evidance of any resulting health problems from this complaint.

This incinerator has a capacity of burning up to 3 tons of liquid chemicals a day. Less if water content is high.

TRIP TO PESTICIDE STORAGE DEPOT OF SUDAN PLANT PROTECTION DEPARTMENT AT KHARTOUM

I accompanied Dr. Munir Sabra of the PPD to inspect a storage depot on the outskirts of Khartoum. The pictures I took will accompany this report in its final format.

There were pesticides in 5 liter cans that were stored so long in the weather the cartons had disappeared. Dr. Munir said this pile of about 7-10 thousand liters (1500-2000 cans) had been there seven years. The only information legible on the label was they were manufactured by Sandos Chemical of Basle, Switzerland.

There were pressurized bottles of Bromine gas, adjacant to empty 200 liter drums - unidentifiable - that had contained some chemicals. The ground was thoroughly saturated with the leacate from these leaking containers.

Inside the four storage buildings (one of which was used as a home for the two security guards), ventillation was nearly non existant. The dirt floors were covered with powdered pesticides that had been removed, and the pesticide scattered - in low concentration - in the desert area of northwest Sudan. The four buildings were:

lea 15' x 15' approx. (This is the one the security guards used as home).
lea 15' x 30' approx. (One that powder had been removed from).
lea 12' x 15' approx. (A Rodancide was stored in here. Odor very bad).
lea 15' x 30' approx. (Locked. Key unavailable).
Open storage was 35' x 125'.

This depot was located in an area of small farms, and residences. There have been complaints from the neighbors concerning the odor, which was bad.

This depot is regarded by PPD as one of the worst in the Sudan. But even improvement of storage facilities by a magnitude of ten would be unacceptable by European or U.S. standards.

This situation is not unique to the Sudan. The same horror stories abound in each African country to some extent. The inventory of these depots are nearly complete in the Sudan and there is over two hundred tons identified so far.

Conclusions:

Due to the deplorable state of storage of left-over pesticides in Sudan, Ivory Coast, Mali, Senegal and to a lesser degree Kenya leads one to the conclusion that this is not acceptable environmentally or from human and animal health standards. Seven years is a long time to store unused chemicals, in the open, adjacent too populated areas.

I would suggest a trial program to try to incinerate these liquids and powders, using old drums cut in half for the powders. This may require some air emission monitoring (available from EPA or outside consultant firms). It should be done in remote areas, and perhaps the residue ash broadcast over wide areas on top of the desert.

As one giant blow torch is available in the Sudan, this is the logical place to try the test program. They have the four necessary ingrediants for success:

1. Need for action in disposal of left-over pesticides.
2. Machine ready for use, owned by a company (Shell) willing to undertake this venture.
3. Willingnes of PPD to assist and co-operate in a trial project.
4. AID officials who recognise the importance of developing a solution to the problem.

If the trial, with modifications as required, proves viable this could become a model for other African nations, with similar problems, to duplicate.

The trial might include some of the technical drums, which have been emptied but sill contain some residue found at some of the smaller pesticide plants.

In discussions with Dr. Munir of PPD and Dr. Mackie of AID office Khartoum, both were agreeable to off gas testing. Shell indicated they would be agreeable if test results were verifiable and Shell had access to the results.

The alternates to trial incineration, as I see it, are:

1. Install necessary equipment in a fixed location to chemically destroy the active ingrediant by using NAOH @ 50 degrees C at PH 12.5+. This becomes somewhat difficult when dealing with E.C. solutions or W.P. concentrates due to emulsifiers. Acid can then be added to lower PH to acceptable level for discharge, after filtering.
2. Continue to store chemicals throughout the countryside in depots.