



AMERICAN PUBLIC HEALTH ASSOCIATION
International Health Programs
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REVIEW OF REQUEST FROM THE ZANZIBAR
GOVERNMENT FOR SUPPORT OF A PHARMACEUTICAL
PLANT FOR THE PRODUCTION OF CHLOROQUIN TABLETS
FOR THE ZANZIBAR MALARIA CONTROL PROJECT
(621-0163)

A Report Prepared By:

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EXECUTIVE SUMMARY

In order to fully implement Phase II of its pharmaceutical manufacturing plant project and be able to produce its own antimalarial tablets, chloroquine, the Zanzibar Government has requested certain essential equipment, primarily mixing and accessory equipment, and tooling from the U.S. Agency for International Development.

The purpose of this assignment is to review the request from the Zanzibar Government for support of a pharmaceutical plant for the production of chloroquin tablets. Specifically, the consultant was asked to review the adequacy of the equipment requested as well as the reasonableness of the costs.

Although inadequate information was provided by the requester to enable the author to conduct a comprehensive evaluation of the request, the costs for the requested items, in U.S. dollars have been estimated at \$176,914.00, as detailed in this report, excluding a small number of production related items for which inadequate information was provided to enable the consultant to conduct a professional evaluation.

While the absence of a listing of currently available equipment and ancillaries and the non-reproducibility/unreadability of a large part of the documents submitted hampered this evaluation, it has been determined that the request is reasonable and that the essential production equipment indicated as being already on hand and those included in this request are adequate to support the production plan of the Zanzibar Government's pharmaceutical tableting plan through 1989 and beyond. With existing tablet presses and requested mixing equipment--the time-limiting items in tablet production--the Zanzibar plant will be able to produce almost 900 million tablets per year. This capability is comfortably in excess of their projected plant capacity of 500,000,000 tablets per year.

However, it recommended that such high level production on the two tablet presses indicated as being on hand will necessitate a thorough reassessment of the adequacy of the number of tooling sets for these two units, if production is not to be unnecessarily hampered in the near future.

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ABBREVIATIONS

AID	Agency for International Development
HSD	Health Services Delivery
MOH	Ministry of Health
S&T	Bureau for Science and Technology
UNIDO	United Nations Industrial Development Organization

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INTRODUCTION AND BACKGROUND

Purpose of the Assignment

The purpose of this assignment is to review the request from the Zanzibar Government for support of a pharmaceutical plant for the production of chloroquine tablets. Specifically, the consultant was asked to review the adequacy of the equipment requested as well as the reasonableness of the costs.

In his request to the pharmaceuticals advisor, Dr. Rosalyn C. King, S&T/Health/HSD, A.I.D./Washington, Paul G. Ehmer, health development officer, A.I.D./Dar es Salaam, Tanzania, stated that the plant manager originally indicated that all required to produce tablets would be the anti-malarial raw materials. Subsequently, the plant requested certain essential equipment, primarily mixing and accessory equipment, and tooling to enable them to continue present production. In the interim, A.I.D./Dar es Salaam was moving to purchase 2,000,000 tablets of chloroquin for immediate needs while Zanzibar's equipment request is being assessed.

Background

The Zanzibar Government established a small pharmaceutical plant in 1966 for the manufacture of various dosage forms. The plant is currently in operation and is producing aspirin, sulfaguanadine and some vitamin tablets.¹ In order to increase their production capacity to enable the production of anti-malarial products, the Government has identified additional equipment needed for this purpose and requested same through USAID.

Prior to 1964, Zanzibar imported all of its pharmaceuticals.² In 1964, the Zanzibar Government recognized the necessity of having pharmaceutical manufacturing capability and, two years later, established a small manufacturing unit. Due to problems associated with limited space, limited equipment and inadequate planning technology, the Zanzibar Government determined in 1976 that a new pharmaceutical manufacturing plant would be built. The new plant would be designed to meet the island's requirements for essential drugs, as well as partially support future needs of the mainland. Expert assistance was made available through U.N.I.D.O. in 1979.

Utilizing a vacant facility, Zanzibar MOH began preparation of intravenous fluids in 1966. In 1968, tablet production was initiated with the acquisition of a mixer and tableting machine. In 1976, the government began construction of a modern pharmaceutical production plant with technical and material assistance from U.N.I.D.O. In July 1981, Phase I of the construction was completed and became operational: IV fluid preparation, tablet production, laboratory facilities and offices. Phase II,

planned to provide added capacity for production of oral liquids, ampoules, and vials, was due for completion in June 1982. An engineer, a pharmaceutical formulation expert and a chief technical advisor have all been provided by U.N.I.D.O. for periods of 18 months to four years. The engineer was scheduled to be available through Phase II; the production/formulation expert was scheduled to be on site until 1984; and the chief technical advisor was to complete his four-year assignment in 1983.

Three specially trained pharmacists hold the major management positions at the manufacturing plant: General Manager, Production Manager, and Quality Control Specialist. They are supported by some 22 pharmaceutical production assistants. The present staff of 42 (1982) is planned for expansion to 65 during Phase II when production capacity rises to some one million tablets per day.

Projected requirements for various pharmaceuticals and proposed plant capacities are presented in Table I.³

TABLE I

PRODUCT GROUP	REQUIREMENTS		NEW PLANT CAPACITIES
	1985	1989	
1. Tablets	306,000,000	405,000,000	500,000,000
2. Capsules	7,500,000	10,000,000	20,000,000
3. Oral Tablets/Galenicals	200,000L	250,000L	250,000L
4. Ointments	7,500Kg	10,000Kg	10,000Kg
5. Sterile Powder/Injection	900,000	1,200,000	2,000,000
6. Sterile/Liquid(Vial)	600,000	900,000	2,000,000
7. Sterile Liquid (Ampoules)	750,000	1,000,000	2,000,000
8. Intravenous Fluid	16,000L	24,000L	250,000.000L

Production Plan

The production plan for the Zanzibar pharmaceutical manufacturing facility, in tablet units per year, is comprised of the following products and quantities:

TABLE II

PRODUCT	STRENGTH	QUANTITY
1. Chloroquine Phosphate	250mg	30,000,000
2. Aspirin	300mg	20,000,000
3. Ferrous Fumarate	300mg	10,000,000
4. Multivitamins	BPC	10,000,000
5. Vitamin B-1	50mg	1,000,000
6. Vitamin B Complex	BPC	10,000,000
7. Ascorbic Acid	100mg	8,000,000
8. Piperazine Tartrate	500mg	5,000,000
9. Magnesium Trisilicate Co	250/12mg	4,000,000
10. Unreadable	300mg	1,000,000
11. Unreadable	—	2,000,000
12. Unreadable	—	1,000,000
13. Paracetamol	500mg	10,000,000
14. Sulphaguánidine	500mg	2,000,000
15. Sulphadimidine	500mg	1,000,000
16. Phenylbutazcne	—	2,000,000
17. Aminophylline	—	<u>2,000,000</u>
Total		119,000,000

Source: Memo from American Embassy, Dar Es Salaam to Secretary of State, Washington, D.C., 12 March 1982.

OBSERVATIONS AND FINDINGS

Assessment of Costs of Proposed Equipment and Ancillary Additions

(Note that pharmaceutical manufacturing and processing equipment is routinely custom manufactured to fulfil specific plant requirements; therefore, prices given for these items are company estimates or price ranges.)

A combination of the following techniques was utilized in assessing costs for the items requested:

1. Review of recent "in house" quotations;
2. Review of current catalogs
 - a. Fisher Scientific Company
 - b. Arthur H. Thomas Company
 - c. Sargent-Welch
3. Telephone calls to confirm or update prices.

A. MACHINES AND EQUIPMENT TO SUPPLEMENT EXISTING ONES IN ORDER TO IMPROVE THE PRODUCTION YIELD AND TO ENSURE SMOOTH AND STABLE PRODUCTION.

- | | | |
|--|---|------------|
| 1. Fitzmill, Standard Model S44-D6 | | |
| a. Manually fed (OR) | 1 | \$9,500.00 |
| b. Machine fed | 1 | 13,000.00 |
| 2. Mixing Machine, Stainless Steel, 170 Liter, Wet or Dry, Manesty Model 300 | 1 | 6,600.00a |
| 3. Tilting Pan, Steam Jacketed, 100 Liter Capacity | 4 | 10,800.00a |

B. STORAGE AND TRANSPORTATION EQUIPMENT FOR TABLET SECTION

- | | | |
|---|----|----------|
| 1. Pallet Lift Truck, Hand Operated, Hydraulic, 1 Ton | 1 | 950.00 |
| 2. Storage Pallets, 1 Meter Square | 48 | 1,200.00 |
| 3. Containers, Stackable, Stainless Steel, 50 L (5 Sets of 5) | 25 | 1,250.00 |
| 4. Skids (Trolleys) for Above | 5 | 250.00 |

C. ANCILLARIES

- | | | |
|---|--------|--------|
| 1. Granulation Mesh, Stainless Steel, Size 8 (Imperial), 8 holes per linear inch in rolls of 1mx20m | 2rolls | 600.00 |
| 2. Granulation Mesh, Stainless Steel, Size 12 (Imperial), 12 holes per linear inch in rolls of 1mx20m | 2rolls | 600.00 |
| 3. Granulation Mesh, Stainless Steel, Size 14 (Imperial), 14 holes per linear inch in rolls of 1mx20m | 2rolls | 600.00 |
| 4. Granulation Mesh, Nylon, Size 8 (1mx20m), roll | 2rolls | 480.00 |

5. Granulation Mesh, Nylon, Size 12 (1mx20m), roll	2rolls	480.00
6. Scoops, Stainless Steel, to Scoop Out 1 Kg Powder	3	99.00
7. Scoops, Stainless Steel, to Scoop Out 0.5 Kg Powder	3	90.00
8. Tins for Packing of Tablets, Size 301mmx409mm	30,000	7,500.00
9. Tins for Packing of Tablets, Size 410mmx411mm	10,000	2,800.00
10. Cotton for Packing	22,000 x 500Gm	N/A

D. SPARE PARTS AND TOOLING FOR EXISTING TABLET MACHINES

☐☐☐	For Rotapress MK II, Manesty 45 Stations (\$103,000.00) Existing Equipment For Bi-Layer Capability, Add: \$20,000.00		
1.	Set of Punches and Dies, Upper and Lower, 6 mm Diameter		
a.	Plain, Standard Round Concave	50	\$1,750.00
b.	Embossed, Standard Round Concave, \$45/Station	50	2,250.00
c.	Hob Charge (One-Time) for Embossing	-	150.00
2.	Set of Punches and Dies, Upper and Lower, 9mm Diameter		
a.	Plain, Standard Round Concave	50	1,750.00
b.	Embossed, Standard Round Concave	50	2,250.00
c.	Hob Charge (One-Time) for Embossing	-	150.00
3.	Set of Punches and Dies, Upper and Lower, 12mm Diameter		
a.	Plain, Standard Round Concave	50	1,750.00
b.	Embossed, Standard Round Concave	50	2,250.00
c.	Hob Charge (One-Time) for Embossing	-	150.00
4.	Dust Extractor Unit, Manesty Minimaster, 20mm, Complete, Part #5002500	1	2,800.00a
☐☐☐	For Manesty BB3B Tablet Press, 35 Stations (\$35,000.00) Existing Equipment For Bi-Layer Capability, Add: \$5,000.00		
1.	Set of Punches and Dies, Upper and Lower, 6mm Diameter		
a.	Plain, Standard Round Concave	30	1,050.00
b.	Embossed, Standard Round Concave	30	1,350.00
c.	Hob Charge (One-Time) for Embossing	-	150.00
2.	Set of Punches and Dies, Upper and Lower, 9mm Diameter		
a.	Plain, Standard Round Concave	30	1,050.00
b.	Embossed, Standard Round Concave	30	1,350.00
c.	Hob Charge (One-Time) for Embossing	-	150.00
3.	Set of Punches and Dies, Upper and Lower, 12mm Diameter		
a.	Plain, Standard Round Concave	30	1,050.00
b.	Embossed, Standard Round Concave	30	1,350.00
c.	Hob Charge (One-Time) for Embossing	-	150.00
4.	Nylon Plungers, #6385190	30	7.50a
5.	Retaining Screws, #6396900	30	3.87
6.	Lower Cam Track Assembly, #6370150	2	1,560.00a
7.	Starter with Overload	1	275.00a
8.	Pressure Roll Assembly, #6350070	1	1,650.50
9.	Variable Speed Pulley Bore	1	189.00a
10.	"V"Belt, #6366430	2	342.30
11.	Ball Bearings, #6350510 (SKF ALS 9)	2	181.68
12.	Worm, #6350420	1	510.00
13.	Ball Bearings, #6370590 (SKF ALS 10)	2	180.12
14.	Sealing Ring, #6371140 (NILCS Type AV)	3	37.35
15.	Ball Bearings, #6363710 (LJ 3/8"), 1 3/8	2	181.68
16.	Die Screw Assembly, #6361560	50	8,250.00
17.	Front Feed Frame Assembly, Deldrin, #6372100	2	1,498.00a
18.	Rear Feed Frame Assembly, Deldrin, #6372100	2	1,498.00a
19.	Front Take Off Plate, #6370790	2	21.50
20.	Rear Take Off Plate, #6370800	2	21.50

21. Upper Cam Track Lifting Side, #6370940	2	635.00
22. Scraper Springs, #6370770	2	1.70
23. Upper Cam Track, Lowering Side, Complete, #6370950	2	460.00
24. Pressure Roll Assemblies, #6350070	2	1,177.00
25. Upper Cam, Complete, #6370930	1	785.00
⋮ Mitchell Dryer, Model 80E		
1. Heater Elements, Type SE 32	12	480.00a
2. Cambridge 6", Indicating Type, Thermostat, Range 20-220°C	1	58.00a
3. Ball Bearings, 1 3/4" SKF Self-Aligning	4	364.00a
4. "V"Belt for Fan	3	346.00a
⋮ Weighing Scales for Tablet Section		
1. Scale, Fully Automatic Pointers, Bench Model, Capacity 3kg, Readability 0.05G	1	1,998.00
2. Scale, Fully Automatic Pointer, Bench Model, Capacity 50kg, Readability 1.0G (Carl Kolb, West Germany, Cat. No. 164-455)		
(Sartorius 3807 MP6/BCD)	1	5,000.00
3. Balance, Electronic Digital Top Pan, Sartorius 1200 Series, Weighing Range 30G, Readability 0.000G (S-1212)	3	1,800.00

E. GENERAL EQUIPMENT, MACHINERY AND TOOLS

These items were not evaluated by the consultant as they are outside the scope of his special expertise.

F. LABORATORY EQUIPMENT

1. Incubator, Refrigerated, Range - to 350°C, 220V, 50 Hz	1	\$1,800.00
2. Incubator/Heating Oven Combined, Up to 250°C, 425mm x 320mmx390mm, 220V	1	800.00
3. Rack for 52 Tubes, 0 to 13mm In Dia	1	25.00
4. Water Bath, Thermostatic, Comprising 177-525 and 20 L Batch, 30cmx40cmx15cm, 220V	1	925.00
5. Refrigerator/Freezer Combined, 210/113 L Model 3923, 220V, 50Hz Lab-Line 8050-E15/Model 3551-10, Flammable	1	1,800.00
6. Incubator, 115L, Ambient to +120°C with Aluminum Chamber Shelves, 220V, 50 Hz, 60cmx40cmx48cm	1	250.00
7. Colony Counter, New Model, 220V, 50 Hz, with Fluorescent Illuminator and Automatic Counting by Pressure on Petridish	1	888.00
8. Vacuum Pump, Portable, 26L/min.	1	325.00
9. Sterilizer, Hot Air, 50x48x50cm, 220V, 50 Hz	1	1,200.00
10. Microscope, Routine Binocular, 40-1250X, with Mechanical Stage, 5 Achromats, 8x and 10x Eye Pieces, 6V/10W Illuminator, 220V,	1	800.00
11. Fluorometer, Turner 111 Filter Including Filter, Spare Lame and Test Kit, 110V, 50 Hz	1	2,990.00
12. Transformer, Stepdown, 220/110V	1	40-250.00
13. Drying Oven, Vacuum, to 180°C, 11L, 220V	1	1,400.00
14. Balance, Precision, 200G, 2 Pan, Hardwood Base	1	575.00
15. Centrifuge, Small Deluxe Model, With Speed Selector and Timer, 220V, 50 Hz	1	500.00
16. Universal Rotor, 16x15ml, Complete with Omnifuge	1	925.00a
17. Kjeldahl Digestion Apparatus, 500ml, 6-Place, Macro with Forked Rods, 220V, 50/60 Hz	1	2,995.00
18. Suction System, Spare, 6-Place Macro	1	N/A
19. Water Jet Punch for Suction System	1	N/A
20. Shaker, Rotary, 70-530 rpm, 220V, 50 Hz		
a. 8-Flask	1	615.00
b. 14-16-Flask	1	850.00
21. Universal Top with 3 Clamping Strips	1	83.00
22. Dissolution Tester, Type DT-D, Consisting of Water Bath with Thermostat, One Round Bottom Flask, One Quick Release Chuck, Complete with Shaft 1118A, 20-100rpm, 220V, 50 Hz (Erweka)	1	4,500.00
23. Stirrer, Magnetic, 80-1500 rpm, w/o Heating, w/Stirring Bar, 220V, 50 Hz	1	235.00
24. Water Bath, 6 Openings, 90mm Diameter, 220V (Blue M)	1	1,087.00a
25. Muffle Furnace, VP to 1600°C, 220V, 50 Hz with Electronic Control System	1	1,825.00
26. Viscometer, Oswald Micro, Manual	1	38.00
27. Tablet Hardness Tester, Type TB-24, Semi-Automatic, Measuring Range 0-15kg, 220V, 50 Hz (Erweka)	1	3,600.00
28. Moisture Tester, Ux70 for Tablets, Powders/Granules, 220V, 50 Hz	1	980.00
29. Friabilator, Tablet Testing Apparatus, Diameter of Drum 30cm, 220V, 50 Hz (Model TARD, Erweka/RAC)	1	2,100.00
30. Sieving Machine, Up to 1200 Oscillations per Minute, w/o Sieves	1	550.00
31. Balance, Analytical, 0-200G Capacity, Readability 0.05mg, One Pan, Digital Optical Taring, 110/240V (Sartorius 2405)	1	2,800.00

32. Voltage Regulator, Line, 3-Phase Input, 3x220V, ___% Output, 3x220V +1%, 5KVA, 16A		98.00
33. Spectrophotometer, Pye-Unicam (??)		*
34. pH Meter, Digital (Phillips) Orion Model 601A		985.00
35. pH Meter, Corning Weel Model 10		1,180.00
36. Tablet Disintegration Tester, Manesty		??
37. Saccharometer YSI Model 27, Industrial Analyzer (Sugar), Semi-Automatic		4,690.00
38. Balance, Sartorius Chemical		655.00
39. Glassware for Volumetric Analysis	*	.
40. Liquid Viewer for Particulate Matter	*	.
41. Pyrogen Test Temperature Instrument	*	.

*Insufficient information supplied to enable cost assessment by consultant.

G. TOTAL ESTIMATED COSTS FOR ALL ITEM GROUPINGS	\$176,914.00
1. Total Estimated Costs for Groups A, B, C, D and F	\$141,531.00
2. Rule-of-Thumb Estimate for General Equipment, Machinery, <u>and Tools (25% of A+B+C+D+F)</u>	35,383.00

Assessment of Plant Capacity Versus Projected Requirements

The adequacy of the equipment and ancillary items was assessed by doing the following:

1. Noting the maximum capacity or output for the item of production equipment.
2. Assuming "downtime" consistent with the projected effective work hours/year.
3. Assuming that equipment and machinery cannot be operated at maximum capacity for extended periods of time without serious damage either to the machinery itself or to its components (tooling, etc.).
4. Output arrived at after consideration of the above assumptions was then compared with the output necessary to enable the plant to meet its projected production requirements.

A. Work Year

1. Effective Work Days

52 Weeks per Year @ 5 Days/Week	=	260
2 Weeks Annual Leave/Year @ 5 Days/Week	=	<u>-10</u>
LESS		
2 Weeks of Official Holidays @ 5 Days/Week	=	<u>-10</u>
Effective Work Days per Year	=	240

2. Effective Machine Hours per Year

240 Work Days @ 5 Hours/Work Day Shift	=	1,200 Hours/Yr
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B. Plant Production Requirements for Tablets (Projected)

1. Now	119,000,000 Tablets
2. By 1985	306,000,000 Tablets
3. By 1989	500,000,000 Tablets

C. Tablet Machine Production Capacity Required

1. Now - 119,000,000 Tablets/1,200 Hours =	99,167 Tablets/Hour
2. By 1985 - 306,000,000 Tablets/1,200 Hours =	255,000 Tablets/Hour
3. By 1989 - 500,000,000 Tablets/1200 Hours =	416,667 Tablets/Hour

D. Bulk Tablet Mixture Processing Capacity Required

1. Assumptions:
 - a. The average tablet weight will be 500 mg
 - b. The loss on processing will average 10 percent
2. Now: (119,000,000 Tablets)(0.500Gm/Tablet)(110%) = 65,450kg
Hourly processing capacity for bulk mixture = 54.542kg
Daily processing capacity for bulk tablet mixture =
54.54kg/Hour x 5 Hours/Day = 272.8kg/Day

3. <u>1985</u> : (306,000,000 Tablets)(0.5Gm)(1.10)	=	168,300kg
<u>Hourly</u> processing capacity for bulk mixture	=	140.3kg/Hour
<u>Daily</u> processing capacity of bulk mixture	=	701.5kg/Day

E. Capacities of Existing Tablet Presses:

	<u>Maximum per Minute</u>	<u>Maximum per Hour</u>	<u>Maximum per Day</u>	<u>Maximum per Year</u>
Manesty Mk II Rotapress (45)	8,200	492,000	2,460,000	590,400,000
Manesty BB3B Press (35)	2,980	178,800	894,000	214,560,000
Combined Capacities	<u>11,180</u>	<u>670,800</u>	<u>3,354,000</u>	<u>884,960,000</u>

Therefore, tablet press capacities are adequate in that they exceed maximum projected plant capacities for tablets by a comfortable margin of 385 million tablets per year.

F. Capacities of Existing Mixing/Blending Equipment:

The Fitzmill (standard model S44-D6) and the Manesty dry and wet mixing machine (model 300) are both suitable for batch and continuous processing at a level adequate to handle the Zanzibar plant's projected requirements.

Problems and Constraints:

The Zanzibar Government's proposal identified equipment and ancillaries being requested to round out their capability for manufacturing chloroquine tablets. However, existing equipment and ancillaries available or on order were not listed or identified. Tooling and spare parts for the following items of equipment were requested, indicating that these items were existing pieces of equipment: Manesty Mk II 45-station Rotapress, Manesty BB3B 35-station tablet press, and Mitchell Dryer Model 80E. Consequently, it is impossible to determine conclusively the adequacy or reasonableness of the Zanzibar request with information submitted. This review constitutes an analysis of minimum equipment requirements to enable the pharmaceutical plant to produce projected quantities of pharmaceutical tablets versus the effective outputs of the above items along with others requested in Zanzibar's proposal.

Materials submitted for evaluation by this consultant were very difficult to read. In fact, some of the material was unreadable after considerable effort. Consequently, more time was required for this assessment than would have been required for legible materials.

RECOMMENDATIONS

This consultant has but a limited list of recommendations. Had there been more information about the current Zanzibar pharmaceutical manufacturing facility and its available equipment, it may have been possible to make specific recommendations to both A.I.D. and the requesting government. The following general recommendations are made:

1. That a complete listing of existing pharmaceutical equipment be obtained from the requesting government and reviewed along with this consultant's report in making the final decision for A.I.D. on the Zanzibar Government's request; to include:
 - a. Production and packaging equipment;
 - b. Quality control equipment; and
 - c. Materials handling equipment.
2. In view of the heavy production load projected for the two tablet presses, that the adequacy of the number of sets of tooling (punches and dies) be reassessed after it is known just how many sets are already on hand for production. Unless backup sets are provided, tablet production can be seriously compromised due to the excessive wear and tear on the existing tooling, rendering them inoperable in a much shorter period of time.
3. That the production pharmacist(s) be urged to consider adopting the dry granulation technique (utilizing slugging of dry powders and dry granulation of the slugs) for select products as a means of enhancing the shelf-life of their product and to effect economies in time and raw materials utilized.
4. That the production pharmacist(s) be urged to consider the addition of a 2-3 suitable capacity "V" or double cone solids/liquids blenders, if such equipment is not currently available.

REFERENCES

1. Letter from Paul G. Ehmer to Dr. Rosalyn C. King, November 4, 1982.
2. Memo entitled "Pharmaceutical Preparations for Zanzibar Malaria Control Project (621-0163)," Embassy Dar es Salaam, March 1982.
3. Letter from Ministry of Health and Social Welfare, zanzibar, to the U.S. Agency for International Development, Dar es Salaam, July 24, 1982.
4. Brochures and Personal Communications from:
 - a. Thomas Engineering Company
 - b. Raymond Automation Company
 - c. Fitzpatrick Company
 - d. Pennwalt-Stokes

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