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A Prototype Study of Delivery of Laboratory Services in Egypt

Laboratory Management Techniques in Health Care

Project 09-397-C

Ministry of Health, Cairo, Egypt

Health Investment Studies Program, Zagazig

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INTRODUCTION

This is a report of the second phase of Project 03-337-C, "Laboratory Management Techniques in Health Care," conducted by representatives of the Center for Disease Control, Public Health Service, Department of Health, Education, and Welfare, United States of America, for the Ministry of Health, Cairo, Arab Republic of Egypt. The agreement for the conduct of this project is described under Section 104(b)(3) of Public Law 83-480, as amended, and Public Law 86-610, Section 3. The period of agreement is for two years, and the proposed project period is from August 23, 1978, through August 22, 1980.

As agreed, the project entails the study of and recommendations for improvement of laboratory services from the Ministry of Health level in Cairo - principally the study of the Central Public Health Laboratories in Cairo (CPHL) - to the lowest level of the delivery of laboratory services - in this case a rural health unit in the Province of Gharbia. This study - especially for Gharbia - would serve as a model or prototype for further provincial studies by the Egyptian members of the project who would observe the United States team during the two-year span of the project. Of significance was the selection of Gharbia Province as the model province for the provincial role in the study. Gharbia - is a province of approximately two million people and is considered one of the most important provinces due to its location in the Nile Delta, along with its agriculture and industrial resources. In addition, Gharbia was considered to have a strong health care organization, and its key personnel could serve as an excellent resource for further study and implementation of the recommendations of the report herein.

The first phase of the project entailed a planning visit by the Project Officer from the Center for Disease Control (CDC) during the period January 11-18, 1979. The primary purpose of the visit was to meet the members of the Egyptian side of the project and to more specifically plan the principal areas of emphasis to be studied by the United States project team during the second phase of the project planned for the period February 19 - March 9, 1979.

The members of the Egyptian team who served not only in excellent resource roles during the first and second phase of the project but were instrumental in selecting the facilities to be studied in Gharbia were:

Dr. Amin El Gamal, Principle Investigator, Under Secretary of Health for the major Ministry of Health functions for Laboratories, Environmental Health, and Occupational Health, Cairo.

Dr. Bothaina El Shinnawi, Director General, Central Public Health Laboratories, Cairo.

Dr. Safwat Mohi El Din, Director General, Microbiology, Central Public Health Laboratories, Cairo.

Chemist Adel Gamal El Din, Chief, Water Section, Central Public Health Laboratories, Cairo.

Engineer Shihata Ayad, Chief, Engineering, Central Public Health Laboratories, Cairo.

Dr. Nasr Diab, Director General, Gharbia Health Directorate, Tanta.

Dr. Elias Dib Aziz, Director, Provincial Public Health Laboratories, Tanta.

Dr. Malik El Nomrosi, Consultant in Statistics, Cairo.

Dr. Zahir Iskander, Statistical Function, Ministry of Health, Cairo.

Dr. Monir Atia, Director General, Health Sanitary Services, Ministry of Health, Cairo.

The first phase visit was considered fruitful in that areas needing the most attention and emphasis were more clearly identified. A preliminary report which listed these areas was written prior to the second phase of this project. Copies of the report were given to the Egyptian members of the project on the first day of the United States project team's visit in Cairo, and the project team used the list of these areas as a study guide for completion of the second phase described herein. This list is presented as follows:

1. Clarify laboratory program relationships and needs of the Ministry of Health programs with the CPHL and Provincial Health laboratories. Program functions of the Ministry of Health, CPHL, and Provincial Health organizations must be defined.

2. Determine role of CPHL and if additional programs are necessary.

3. Determine best organization and staffing for CPHL.

4. Study maintenance needs. This involves standardization of equipment, components, and parts. Training for technicians to maintain the equipment, is another aspect - especially for the more sophisticated equipment.

5. Determine if a Preventive Maintenance (PM) program is needed, and how this should be done. This would involve a work order system, equipment card system, depreciation and replacement analysis procedures, and a schedule of inspection points for all equipment placed under a PM system.

6. Develop a laboratory supply system. A problem is the obtaining of supplies (reagents, chemicals, media, expendables, etc.) on a timely basis. The timeliness of obtaining supplies is "tied" very closely to the availability and approval of funds - and certain procurement practices.

7. Develop a manual system for inventory control of supplies and maintenance spare parts (expendable) in consonance with 6. above.

8. Determine training and skill needs and the role of CPHL in alleviating shortages of skilled personnel.

9. Determine CPHL facility needs including layout, biological and chemical safety needs, and if additional renovation and space is necessary.

10. Determine if other programs should be added to CPHL since CPHL is considered the "focal point" for all public health laboratory services in Egypt - especially in the areas of technical supervision and consultation and laboratory licensure.

11. Determine service levels in the Tanta Central Public Health Laboratory. Determine if this should be the focal point of laboratories for Gharbia and if the role of the other public health laboratory in Mehalla should be redefined.

12. Determine service levels (what should be done by test or procedure, equipment, type of personnel) at each of the facility types (hospitals, health units, etc.) in the Province.

13. Study the Tanta central laboratory facility as done for CPHL in 9. above.

14. Determine if a communication system between provincial facilities and CPHL is necessary in regard to reporting of test results for epidemiological and/or disease control considerations, workload indicators, patient care indicators, and other considerations. The mode of transmission must be considered.

15. Determine if an administrative computer system is feasible for CPHL.

16. Analyze the procedures involving specimen receiving, handling of specimen forms, reporting of results, and forms design. The present system appears to be cumbersome.

17. Determine if a cost and efficiency system should be instituted using work time unit and cost accounting procedures presently designed by the Laboratory Management Consultation Office of CDC. This may not be useful if the "full employment" principle is in effect as in some governmental and other organizations in Egypt. This should be explored during the study.

18. Determine if certain tests done by CPHL should be done locally by other laboratories - especially the clinical or individual patient-oriented tests.

19. Visit the Imbaba Fever Hospital Laboratory and determine its relationship to CPHL. This provides a sample of local specialty hospital laboratory work and <u>how</u> it should relate to the CPHL.

20. Consider proposals for service levels, equipment needs, and personnel requirements submitted by the Principal Investigator (Egypt) on September 25, 1978.

In addition to the study of the Ministry and CPHL, as outlined in 1, 2, and 3 above, the following facilities and organizations were selected for study in Gharbia:

Gharbia Health Directorate
Tanta Fever Hospital
Provincial Laboratory (Tanta)
2 School Health Centers (Tanta)
El Menshawy General Hospital (Tanta)
Tanta Chest Hospital & Dispensary
Tanta Malaria Unit
Tanta I, School Health Unit
Tanta II, Maternal Care Unit
Kafr El Zayat District Hospital
Kafr Masseoud Health Unit
Sanadid Health Unit
Basioun District Hospital
Mehalet Menouf Rural Hospital
Mit Hebeish Health Unit
Sabtass Health Unit
Shobar Health Center
Mehalla El Kobra School Health Center I
Mehalla El Kobra Chest Hospital
Defra Health Center

A few of the above facilities were not included in the study since it was found that identical services and laboratory procedures were, for the most part, offered in like facilities. It is believed, however, that more than enough facilities were included for purposes of this project.

In the above regard, the following sections of this report will deal first with the Ministry and then each level down to the lowest health delivery service in the Province.

FINDINGS AND RECOMMENDATIONS

MINISTRY OF HEALTH

The first health organization in Egypt related to present Ministry of Health activities was established in 1798 by the French to protect the French Army against epidemics - especially plague. The French left in 1801 and an Egyptian council was formed with Egyptian physicians and physicians from other countries. Quarantine was a major function and quarantine activities were centered mostly in the two major Egyptian ports, Alexandria and Damietta. Hospitals were established for isolation and treatment of disease and the hospital system as it is today grew from this early system. By 1884 Egyptian health activities were a part of the Ministry of the Interior as the Division of Health. These activities were enlarged until 1920 and a Director General of Health function was placed under the Ministry of the Interior as a major function. From 1920 to 1936 this major health function's policy was to establish hospitals, clinics, rural hospitals and other health activities in the Governates (Provinces). This

continued until 1936, and in this year the Ministry of Health as we know it today became a separate Ministry and a major Egyptian governmental function. Preventive medicine was still considered to be the major program thrust, although curative medicine programs were accelerated so that today they are a very important part of the Ministry's health delivery system plans. Until 1959 all health activities, including laboratories, for the entire country were controlled centrally from the Ministry. After 1959 the Governates assumed control of all health activities within their borders. The national health budget was and is now split for the Ministry headquarters and each Governate. However, the general plan for national health goals and objectives originate in the Ministry in Cairo - as it should be. Input as to these goals and objectives are provided from the Governates. In brief, the Ministry's current* goals and objectives are:

1. Eradication of endemic diseases such as schistosomiasis, other parasitic diseases, gastrointestinal diseases, trachoma, and tuberculosis.

2. Improvement of all preventive programs such as those for quarantine and all infectious diseases.

3. Expansion of curative measures by establishing hospitals, health clinics, and health units in all provinces where needed.

4. Improvement and expansion of ambulance services.

5. Improvement of rural services.

6. Improvement of health education.

7. Improvement of family planning services.

8. Improvement of medical education, admission and training of paramedics, nurses, etc.

9. Improvement of special education program involving health problems of country, such as endemic diseases, infant mortality, etc.

10. Improvement of pharmacy services involving both manufacture and importation of drugs, etc.

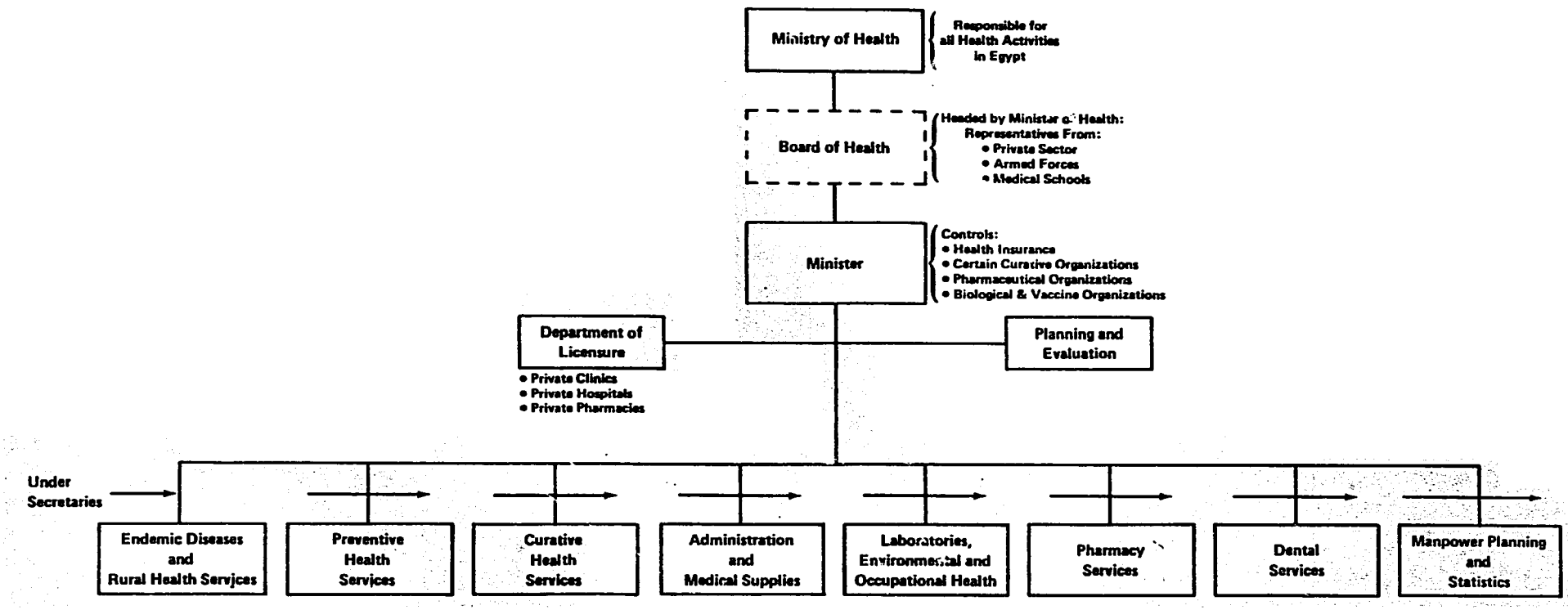
11. Increase health insurance services which started in 1964. (At the present time 2 million workers and their families are insured.)

12. Improvement of export of physicians to other countries to improve their health services.

An organization chart of the Ministry of Health is shown in Figure 1. The generation of laboratory services by the various major functions of the Ministry is shown in Table I; for example, Endemic Diseases, Rural Services and Preventive Health Services. These laboratory services are generated directly by these functions or through Governate functions such as general hospitals or rural

*Source - Dr. Malik El Nomrosi and
Dr. Zahir Iskander.

FIGURE 1
Present Organization — Ministry of Health
Cairo, Egypt



Source: Dr. Malik El Nomrosi and Dr. Zahir Iskander

TABLE I

GENERATION OF LABORATORY SERVICES BY MINISTRY FUNCTIONS
EITHER DIRECTLY OR THROUGH GOVERNATE HEALTH ORGANIZATIONS

		Type Laboratory Activity Generated														
		Diagnostic Analyses							Public Health Analyses							
Ministry Function	Code *	Bio-Chem	Hema	Histo-path	Bacti	Virol	Parasit	Mycol	Micro	Water	Food	Ind & Waste Water	Air & Soil	Toxi	Surf. & Sub-Soil Water	Other
Chest Disease Dept.	C	X	X		X		X									
Nutrition Dept.	P															
Rural Health Dept.	E	X	X				X									
Nursing Dept.	C															
Leprosy Control Dept.	P	X			X		X									
Mental & Psych. Dept.	C	X	X				X							X		
General Hospitals Dept.	C	X	X	X	X		X									
Skin & Ven. Dis. Dept.	C			X	X		X	X								
Radiology Dept.	C															
Radiation Control Dept.	O		X													
M & CH Dept.	P	X	X				X									
Epidemic Diseases Dept.	P	X	X	X	X	X	X	X								
Food Control Dept.	P								X		X					
Quarantine Dept.	P				X	X	X									
School Health Dept.	P	X	X		X		X									
Medical Equipment Dept.	C															
Environmental Health Dept.	O								X	X	X	X	X	X	X	X
Endemic Disease Dept.	E	X	X				X									
Bilh. Control Dept.	E						X								X	
Insects Control Dept.	E						X									
Malaria Control Dept.	E						X								X	
Filaria Control Dept.	E						X									
Poliomyelitis Inst.	C	X	X				X									
Hearing & Speech Inst.	C	X	X		X											
Heart & Chest Surg. Inst.	C	X	X	X	X											
Tropical Disease Inst.	E	X	X	X	X		X									
Diabetes Control Inst.	C	X	X				X									
Rheumatic Disease Inst.	C	X	X				X									
Qaliub Research Center	C		X				X									
Nutrition Center	P	X	X	X	X				X		X					
Ophthalmology Center	C				X	X										
Dental Dept.	F															
Medical Commissions	C	X	X				X									
Blood Banks Dept.	C	X	X		X	X										

TABLE I (Cont.)

Ministry Function	Code *	Type Laboratory Activity Generated: Diagnostic Analyses							Public Health Analyses							
		Bio-Chem	Hema	Histo-path	Bacti	Virol	Parasit	Mycol	Micro	Water	Food	Ind & Waste Water	Air & Soil	Toxi	Surf. & Sub-Soil Water	Other
Pharmacy Dept.	D															
Ophthalmic Diseases Dept.	C				X	X										
Physiotherapy Dept.	C															
First Aid Dept.	C	X	X													
Licensing Dept.	L															
Central Public Health Labs	H	X	X	X	X	X			X	X	X	X		X		

*CODE - Endemic Diseases & Rural Services - E
Preventive Health Services - P
Curative Health Services - C
Pharmacy Services - D
Licensing - L
Central Public Health Labs - H
Environmental or Occupational Health - O
Dental Services - F

SOURCE: CPHL questionnaire - Some relationships were added by U. S. project team since in essence certain programs generated laboratory services indirectly.

health units. Figure 2 shows the organizational relationships of the Ministry to the Governates and the Provincial Health Directorates. Of particular significance in Figure 2 is the autonomy of the Province in administering health programs. This, in essence, is a result of the Egyptian government's efforts - starting in 1960 - to decentralize all health activities possible and make health services available to all citizens. Table II shows the health facilities by type containing laboratories. This shows the need for laboratory services at all health delivery service levels and that the laboratory function is a vital function throughout the Egyptian health delivery system. Tables III - XIV show general information as to the health situation, prevalence and nature of disease and health problems and selected demographic data. As shown, the general population is young (85% below age 45), much of the disease problems affect the young and are infectious - and endemic - in nature, and the life expectancy rate is still considered low. The population is increasing at a rapid rate and, therefore, medical problems - and the demand for medical services will increase substantially. Table XIII shows a significant lack of laboratory services per capita.

Of special significance is the need for not only laboratory services to support this increase in demand for medical services but <u>improved</u> laboratory services, for as the tables indicate, many disease problems requiring laboratory services and data are evident. For example, infectious diseases are a major cause of morbidity and mortality throughout Egypt. Laboratory services to support their control have been severly limited over the years in the apparent favor of supporting many curative facilities, various specialty institutes, medical schools, and special health programs. This, from the viewpoint of the United States project team's observations and by interview of many varied medical specialties during the study, was the primary cause of lack of funds to support an improved laboratory system - as well as an overall limited Ministry budget. (Less than 4 L.E. per capita - see Table VIII.)

Another contributing factor to the lack of laboratory services is the very apparent overlap of program responsibilities which require or generate laboratory services. As shown in Table I (Page 7) and Figure 1 (Page 6) (Ministry organization chart) several undersecretaries and <u>many</u> Departments require or generate laboratory services. It can easily be seen that program conflict can occur if laboratory requirements were to be prioritized to meet Ministry objectives. For example, the Undersecretaries for Endemic Diseases & Rural Health Services, Preventive Health Services, Curative Health Services, Laboratories; Environmental Health and Occupational Health, and in some respects, other Ministry organizations, have their own broad central priorities, and facility requirements, and do not realize the extreme overlap of laboratory support required in, for example, a single governate facility such as a small general hospital. In such a hospital, laboratory procedures that should be accomplished - and data generated - <u>affect all the above Ministry programs</u>. However, with all the overlap (endemic, infectious, chronic, and curative aspects) the general hospital is considered strictly a curative program service and laboratory resources appear to be allocated accordingly - and in some instances - considered as a low priority. Another case in point can be made for the fever hospitals (infectious disease program area or preventive services) where laboratory services, by and large, are felt to be borderline or inadequate. Although the needs for various preventive and curative facilities (such as fever hospitals, chest hospitals, and other specialty health facilities) were not in the purview

FIGURE 2
Organizational Relationship of The Ministry of Health and Governate Health Activities

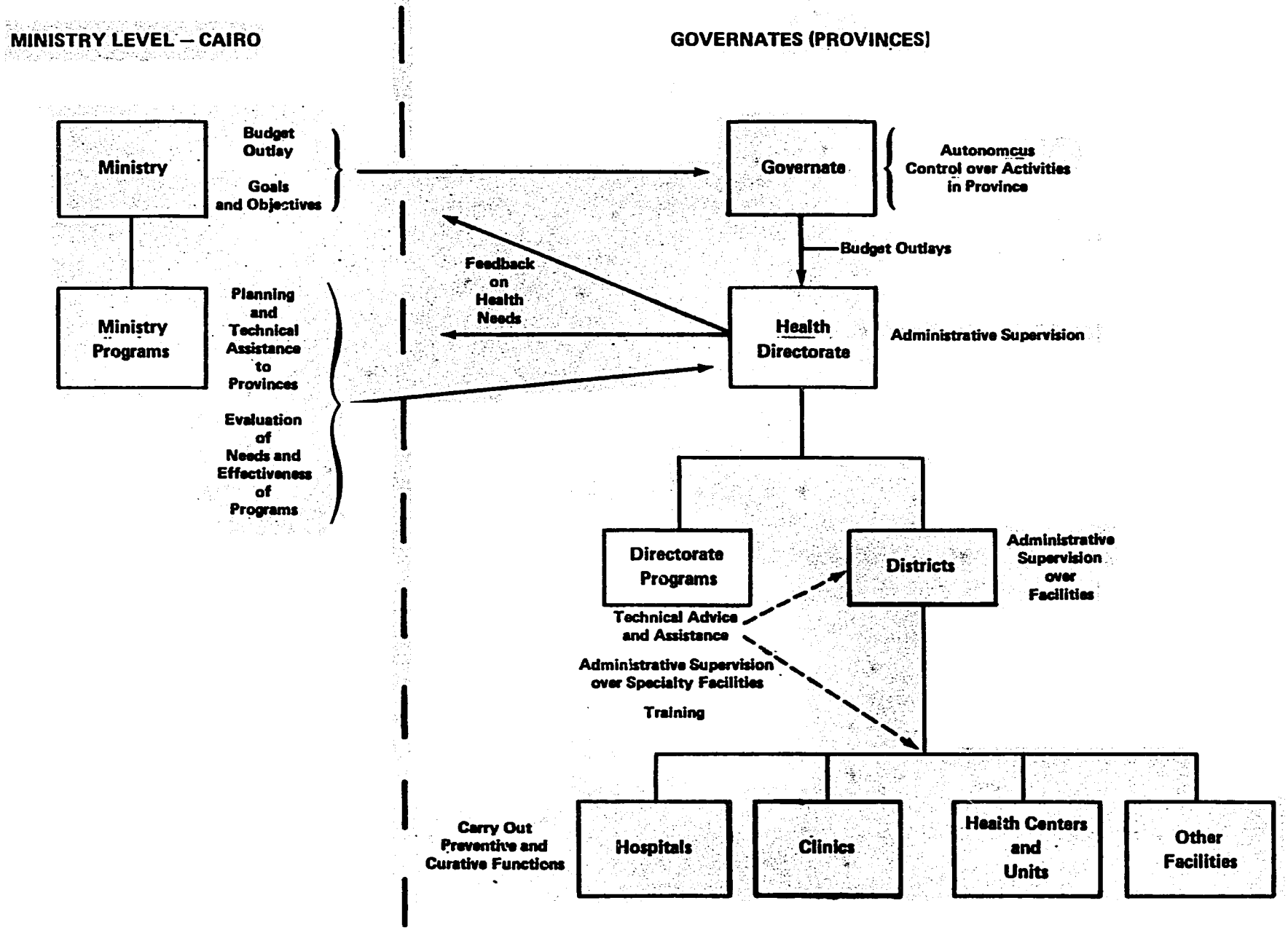


TABLE II

HEALTH FACILITIES* CONTAINING LABORATORIES

EGYPT (25 PROVINCES)

Facility By Type**	Total Number	With Laboratories
LEVEL I		
Rural Health Units	1508	1508
Rural Health Centers	595	595
School Health Units	172	172
MCH Centers	226	226
LEVEL II		
Endemic Disease Units (w/o beds)	12	12
Endemic Disease Units (w/beds)	14	14
Endemic Sections in Gen.Hosp.(w/o beds)	11	11
Endemic Sections in Gen.Hosp.(w/beds)	120	120
District Hospital	132	132
School Health Center	47	47
Urban Health Centers	123	123
Poly-Clinics (Proposed only)	25 est.	25 est.
LEVEL III		
Central Public Health Laboratories	1	1
General Hospitals	38	38
Provincial Laboratories (Some are in General Hospitals)	21	21
LEVEL IV		
Specialized Facilities		
Chest	33	33
OB-GYN	5	5
Psychiatric Clinics	2	2
Psychiatric Hospitals	7	7
Infectious Disease Hospitals	73	73
Eye Hospitals	32	32
Eye Clinics	3	3
Leprosy Hospitals.	4	4
Leprosy Units	14	14
Skin & VD Facilities (w/o beds)	13	13
Skin & VD Facilities (w/beds)	1	1
Tanta Cancer Institute	1	1

*NOTE: The above facility list is not all inclusive, but does contain the preponderance of facilities under the purview of the Ministry.

TABLE II (Cont.)

** Definition of Facility Levels:

Level I

Level I services are the most simple laboratory services done in the following type facilities:

- Rural Health Units.
- Rural Health Centers.
- Mother & Child Health Centers.
- School Health Units.

These facilities perform general blood, urine, and stools analyses.

Level II

Level II services are performed in the following type facilities:

- District Hospitals.
- School Health Centers.
- Endemic Diseases Units, and Hospitals.

These facilities perform general blood, urine, and stools analyses with the addition of some bacteriological tests.

Level III

Level III services are the highest standard of the laboratory services performed in the following facilities:

- CPHL.
- General Hospitals.
- Joint & Provincial Laboratories.

The laboratory services performed in these laboratories are general and special analyses of blood, urine, and stools with advanced haematological, bacteriological, histopathological, biochemical, microbiological, and toxicological analyses. They also perform water and food stuff analyses.

Level IV

Level IV services are a mixture of Level I services and some advanced bacteriological or other type of investigation according to the speciality of the facility. This level includes all the specialized hospital laboratories.

TABLE III

BASIC DEMOGRAPHIC DATA

EGYPT

Population (In Millions)

1952	1960*	1976	1980
21.4	25.8	38.0	40.0

*Last Census

1980 Population Estimate

Males	-	20,405,600
Females	-	19,594,400
		40,000,000

Population By Age (Millions) - 1976

Age Group	Number	Percent
0-4	6.2	16.4
5-9	5.3	13.8
10-14	4.6	12.0
15-24	7.2	19.0
25-44	9.1	23.9
45-59	3.6	9.6
60+	2.0	5.3
	38.0	100.0

Urban and Rural Distribution (Millions) - 1976

	Number	Percent
Urban (138 cities)	16.9	44.5
Rural (4100 villages)	21.1	55.5
	38.0	100.0

Source: Statistical Function
Ministry of Health

TABLE IV

VITAL STATISTICS, LIFE EXPECTANCY, AND POPULATION DENSITY

EGYPT

Vital Rates (Per Thousand)

	1952	1960	1970	1975
Birth Rate	45.2	43.1	35.1	37.7
Death Rate	17.8	16.9	15.1	12.2
Natural Increase Rate	27.4	26.2	20.0	25.5
Infant Mortality Rate	127.0	109.0	116.0	89.2
Neonatal Mortality Rate	20.6	19.3	19.9	--
Maternal Mortality Rate	1.4	1.1	1.1	--
Marriage Rate	10.8	10.9	9.7	10.0
Divorce Rate	3.2	2.5	2.0	2.0

Life Expectancy at Birth (in Years)

	1947	1960	1970	1975
Male	41.4	51.6	50.2	52.3
Female	47.0	53.8	53.3	55.2

Population Density

Total Area A.R.E.	1,002,000 Km^2
Inhabited Areas	35,580 Km^2
Density Total Area (Persons/Km^2)	37.2 - 1975
Density/Inhabited Area (Persons/Km^2)	10,418 - 1975

Source: Statistical Function
Ministry of Health

TABLE V

MORBIDITY

PERCENT DISTRIBUTION OF MAJOR CAUSES OF ILLNESS

GENERAL HOSPITALS - EGYPT - 1975

Males	Percent
1. Accidents, poisoning, and violence	23.8
2. Diseases of digestive system	23.2
3. Diseases of circulatory system	9.9
4. Diseases of genito-urinary system	8.3
5. Others	34.8
Total	100.0

Females	Percent
1. Deliveries and complications of pregnancy, childbirth and puerperium	38.6
2. Diseases of genito-urinary system	13.6
3. Diseases of digestive system	11.9
4. Accidents, poisoning, and violence	7.9
5. Others	28.0
Total	100.0

Source: Statistical Function
Ministry of Health

TABLE V-A

CRITICAL HEALTH AREAS AND ENDEMIC DISEASES
CONTRIBUTING TO MORBIDITY AND MORTALITY IN EGYPT - 1975

Schistosomiasis

Gastrointestinal Diseases
- Intestinal Parasites
- Diarrheal Diseases and Dysentery

Diseases of Infancy and Childhood
- Measles
- Diphtheria
- Mumps
- Whooping Cough

Typhoid and Paratyphoid Infections

Malaria

Trachoma

Tuberculosis

Environmental Health Conditions

Acute Respiratory Diseases

Other Parasitic Diseases
- Filaria
- Amebiasis
- Leishmaniasis
- Intestinal Helminths

Sources: Interviews with Ministry of Health Officials

TABLE VI

CAUSES OF DEATH IN EGYPT (1973)
(INTERMEDIATE LIST OF CAUSES OF DEATH BY
150 CAUSES AS LISTED BY WHO - BY DISEASE AREA)

1. Diseases of digestive system
2. Senility without mention of psychosis
3. Acute respiratory infections
4. Bronchitis, emphysema and asthma
5. Other causes of perinatal morbidity and mortality
6. Other forms of heart disease
7. Other pneumonia
8. Hypertension disease
9. Injuries undetermined
10. Chronic rheumatic heart disease

Source: Statistical Function
Ministry of Health

TABLE VII

MORTALITY

PERCENT DISTRIBUTION OF MAJOR CAUSES OF DEATH IN TOTAL POPULATION (1973)

	Percent
Males	
1. Diseases of digestive system	26.6
2. Diseases of respiratory system	16.3
3. Diseases of circulatory system	14.9
4. Accidents, poisoning, and violence	5.0
5. Other	37.2
Total	100.0
Females	
1. Diseases of digestive system	29.4
2. Diseases of respiratory system	17.6
3. Diseases of circulatory system	12.2
4. Certain causes of perinatal morbidity and mortality	4.6
5. Other	36.2
Total	100.0

Source: Statistical Function
Ministry of Health

TABLE VIII

BUDGET OF HEALTH SECTOR - 1978

(IN EGYPTIAN POUNDS)

MINISTRY OF HEALTH		118,300,000
PUBLIC HEALTH SECTOR*		
Health Insurance Organization		25,970,000
Curative Organization - Cairo & Alexandria		1,524,000
Egyptian Organization for Biological Vaccines		3,654,000
Nasser Institute		120,000
Supreme Council for Family Planning		2,000,000
General Organization of Educational Hospitals & Institutes		5,696,000
Supreme Council for Health Services		10,000
Total	L.C.	157,274,000 **

* Excludes pharmaceutical and chemical industries and university hospitals budget.

** One Egyptian Pound = 1.42 U. S. Dollars.

Source: Statistical Function
Ministry of Health

TABLE IX

COMPARATIVE TABLE FOR REPORTED FEVER CASES

(1965-1975 - CERTAIN DISEASES)

EGYPT

Year	Typhoid	Infectious Hepatitis	Measles	Acute Pneumonia	Tetanus
1965	17,902	11,191	5,588	11,656	1,154
1966	17,584	15,164	12,616	11,894	1,320
1967	15,127	17,466	1,783	8,475	1,611
1968	16,871	19,668	11,843	10,743	1,706
1969	15,118	21,721	2,624	8,967	1,771
1970	9,586	19,031	4,686	7,145	1,785
1971	11,825	22,058	2,253	7,441	2,341
1972	12,860	22,520	4,977	9,432	2,618
1973	14,095	22,914	1,466	6,923	2,847
1974	14,739	23,744	2,597	7,679	3,087
1975	11,555	19,659	3,492	8,864	3,298

Source: Statistical Function
Ministry of Health

TABLE X

LIST OF REPORTED FEVER CASES AND
DEATHS FROM INFECTIOUS DISEASES - 1977

EGYPT

Disease	Cases	Deaths
Cerebrospinal Meningitis	245	55
Typhoid	9,934	71
Diphtheria	573	134
Undulant Fever	11	--
Poliomyelitis	358	2
Infectious Hepatitis	25,225	239
Pulmonary Tuberculosis	1,073	38
Tuberculosis, Other	164	11
Scarlet Fever	26	--
Rabies	36	36
Leprosy	29	--
Measles	3,777	27
German Measles	3	--
Whooping Cough	55	--
Mumps	602	--
New Malaria	297	--
Relapsing Malaria	323	--
Pneumonia	9,625	329
Encephalitis	701	202
Tetanus	3,745	1,323
Chicken Pox	284	--
Influenza	135	1
Puerperal Sepsis	1,427	5
Dysentary	128	--
Erysipelas	1,421	1
Filaria	407	--
	60,604	2,474

Source: Statistical Function
Ministry of Health

TABLE XI

HEALTH PERSONNEL (TECHNICAL)

SELECTED GROUP

MINISTRY OF HEALTH ONLY

(1977)

University Level	Number Employees
Physician	14,419
Dentist	2,327
Pharmacist	2,347
Nurse Supervisor	200
Physiotherapist (Non-physician)	144
Psychiatric & social workers (non-physician)	686
Chemist	309
Biochemist	20
Bacteriologist	72
Sanitarian	3,176
Laboratory Technician	1,716
Laboratory Assistant	Unknown
X-ray Technician	785
Nursing Staff (from schools)	25,420

Source: Statistical Function
Ministry of Health

TABLE XII

NOTIFIABLE DISEASES

MINISTRY OF HEALTH

QUARANTINABLE DISEASES

Cholera	Smallpox
Plague	Yellow Fever
Typhus	Relapsing Fever

OTHER:

Meningitis	Food Poisoning
Typhoid	Measles
Diphtheria	Rubella
Brucellosis	Pertussis
Psittacosis	Mumps
Polio	Malaria
Encephalitis	Pneumonia
Hepatitis A	Tetanus
Hepatitis B	Influenza
Tuberculosis	Dysentery
Leprosy	Amoebiasis
Rabies	Dengue
Dog Bites	Filaria
Schistosomiasis	Rift Valley Fever

Source: Dr. Ahmed El Axxad
Under Secretary of State
Preventive Health Services
Ministry of Health

TABLE XIII

IMPORTANT LABORATORY ACTIVITIES

(1977)

All Governates (Including Gharbia Province)

		Specimens
Bacteriological		2,117,421
Tuberculosis		51,946
Fevers		202,321
Blood		331,494
Biochemical		56,452
Pathological		1,673
Food		268,389
Water		32,597
	Total	3,062,293

Gharbia Province (only)

Bacteriology		126,151
Tuberculosis		891
Blood		872
Food		20,564
Water		7,102
	Total	155,580

Specimens Per Capita

	Population	Total Specimens	Specimens/ Capita
All Governates	38,000,000 (est.)	3,062,292	.081
Gharbia Province	2,000,000 (est.)	155,580	.077

Source: Statistical Function
Ministry of Health

TABLE XIV

IMPORTANT LABORATORY ACTIVITIES

(1977)

MINISTRY OF HEALTH
CENTRAL PUBLIC HEALTH LABORATORIES

	Specimens
BACTERIOLOGICAL LABORATORIES	
Communicable Diseases	184,715
Spirochetes	30,346
Tuberculosis	14,443
Water	11,907
Food	10,725
Viruses	2,100
CLINICAL PATHOLOGY LABORATORIES	
Blood	4,112
Biochemical	10,255
Pathological	1,529
SANITARY CHEMISTRY LABORATORIES	
Food	68,741
Water	17,425
Colours & Preservatives	5,237
TOXICOLOGY	Not Reported

Source: Statistical Function
Ministry of Health

of this study, it is the opinion of the U. S. project team that such separate facilities are now obsolete and are a drain on the Egyptian health budget. They necessitate the duplication and overlap of scarce laboratory resources (as well as other health resources) and, therefore, weaken the entire health delivery system.

From the above, it can be seen that there is no central program or organization in the Ministry at this time which oversees or monitors laboratory needs or effectiveness in support of the Ministry's overall health delivery system. Until such a program is conceived and given the proper responsibility to determine and improve laboratory services, it is believed that Ministry goals and objectives to improve the health of all Egyptians cannot be properly met. It was apparent during the study that a nucleus for such a program exists in the Undersecretary for Laboratories (which, in essence, is called the Central Public Health Laboratories), Environmental Health, and Occupational Health. Work in this laboratory is generated in much the same manner as it is for the aforementioned general hospital. In addition, a distinct public health laboratory function is accomplished.

In the above regard it is recommended that:

1. The Ministry establish the authority for determination of national laboratory requirements and effectiveness of delivery to meet these requirements in a single central Ministry organization. As previously mentioned, a nucleus for this exists in the Central Public Health Laboratories (CPHL) and full consideration should be given for placement of such authority in the CPHL under the Undersecretary for Laboratories, Environmental Health, and Occupational Health. Such a functional responsibility should be relatively autonomous in establishing its priorities and budgetary needs and be the national focal point for all aspects of a national laboratory program. (Such a program is discussed under the next section of this report dealing with the CPHL.)

2. The Ministry establish a commission which would include Ministry of Health officials as well as outside health consultants and authorities for purposes of determining the impact of present duplication and overlap of Ministry program areas and the obsolescence of health delivery facilities. Such a determination should reveal that additional health resources would be available for more efficient and effective use - and provide additional resources for the improvement of delivery of needed laboratory services as well as other health services.

3. The Ministry realize that additional funds must be made available immediately for upgrading laboratory services at all levels.

CENTRAL PUBLIC HEALTH LABORATORIES - MINISTRY OF HEALTH - CAIRO

Health laboratory services in Egypt were initiated by Dr. Bitter, an associate of Robert Koch, at the end of the nineteenth century. These laboratories, called the Hygienic Laboratories, were established in Cairo and their main concern at that time was the diagnosis of cholera and plague. The Central Public Health Laboratories (CPHL) were founded when the Ministry of

Health was established in 1936 as a specialized entity. Since this time, the laboratory system has expanded, under government-sponsored health care, to all provinces within Egypt.

The role of the Central Public Health Laboratories of the Ministry of Health is to fully participate in improving health standards of the population - a major role of the Ministry. This is to be accomplished by:

1. Providing diagnostic facilities for communicable and noncommunicable diseases.

2. Acting as the national reference laboratory of Egypt for the provincial, hospital, and private laboratories.

3. Training laboratory personnel at all levels:

   a. Scientific:

      (1) Medical graduates - bacteriologists; clinical pathologists.

      (2) Science graduates with at least a Bachelor of Science degree such as biochemistry, pharmacy, physics, and chemistry.

   b. Technical

      (1) Laboratory technicians - individuals who have completed secondary school and have two years of theoretical and practical training.

      (2) Laboratory assistants - individuals who have completed eight years schooling and two years training in Central Health Laboratories.

4. Initiating research activities pertaining to health.

5. Directing technical development and standardization of laboratory methodology and administrative procedures in all health laboratories.

6. Controlling foods and drugs whether locally produced or imported.

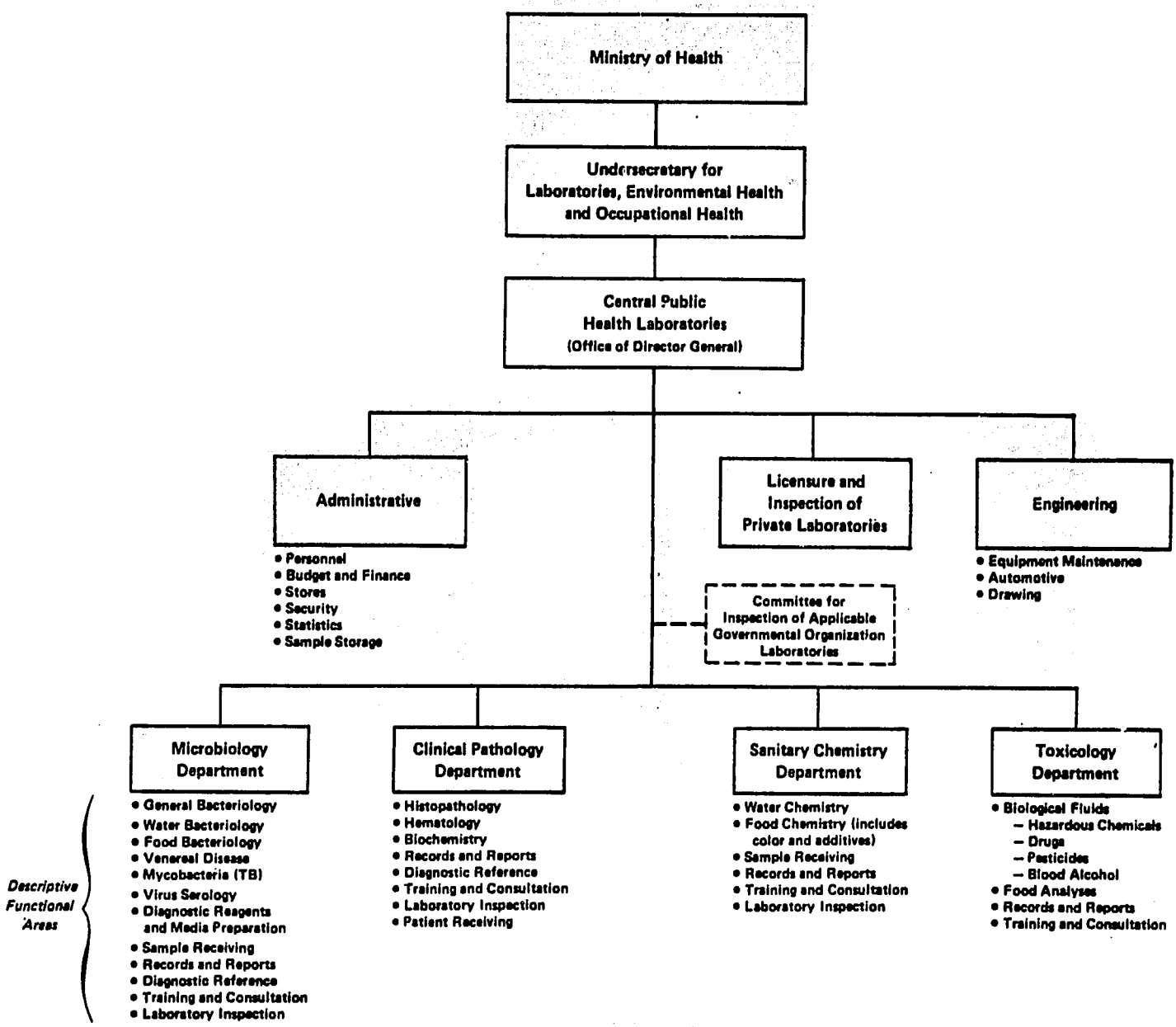
7. Providing consultation to public health workers and physicians.

8. Inspecting governmental laboratories and licensing private laboratories.

The present organization of the CPHL and its general functions are shown in Figure 3.

For the most part, the organization of laboratory services in Egypt is sound. This organization begins at the rural health units and proceeds to a more complex system of laboratory services through rural health centers, rural hospitals, district and/or general hospitals, provincial laboratories and ultimately to the Central Public Health Laboratories in Cairo. In

FIGURE 3
Present Organization and General Functions of Central Public Health Laboratories
Cairo, Egypt



Source: Central Public Health Laboratories Officials

essence the setting of standards and reference work is done in Cairo and the day-to-day diagnostic work is done in the provinces at the above levels. This relationship is depicted in Figure 4.

Much is being done in an attempt to improve CPHL delivery of laboratory services at the Ministry level. Under the excellent leadership of Dr. Amin El Gamal, the Undersecretary for Laboratories, Environmental Health and Occupational Health, added emphasis is being placed on the importance of the laboratory in the delivery of health and medical services in Egypt. He is highly respected in the local medical community as well as known in national public health circles - an essentiality for obtaining and maintaining competent scientists which is critical for the improvement of a national laboratory system. Furthermore, a closer rapport is being established with other Ministry functions as well as Governate health and laboratory functions. This was fully evident during the U. S. project team's visit. He fully recognizes the serious inadequacies in not only the CPHL facility and programs but in the national laboratory system itself. The following lists CPHL inadequacies which were presented to Dr. El Gamal and the Egyptian counterparts to the U. S. project team and recommendations to alleviate or eliminate these inadequacies follow.

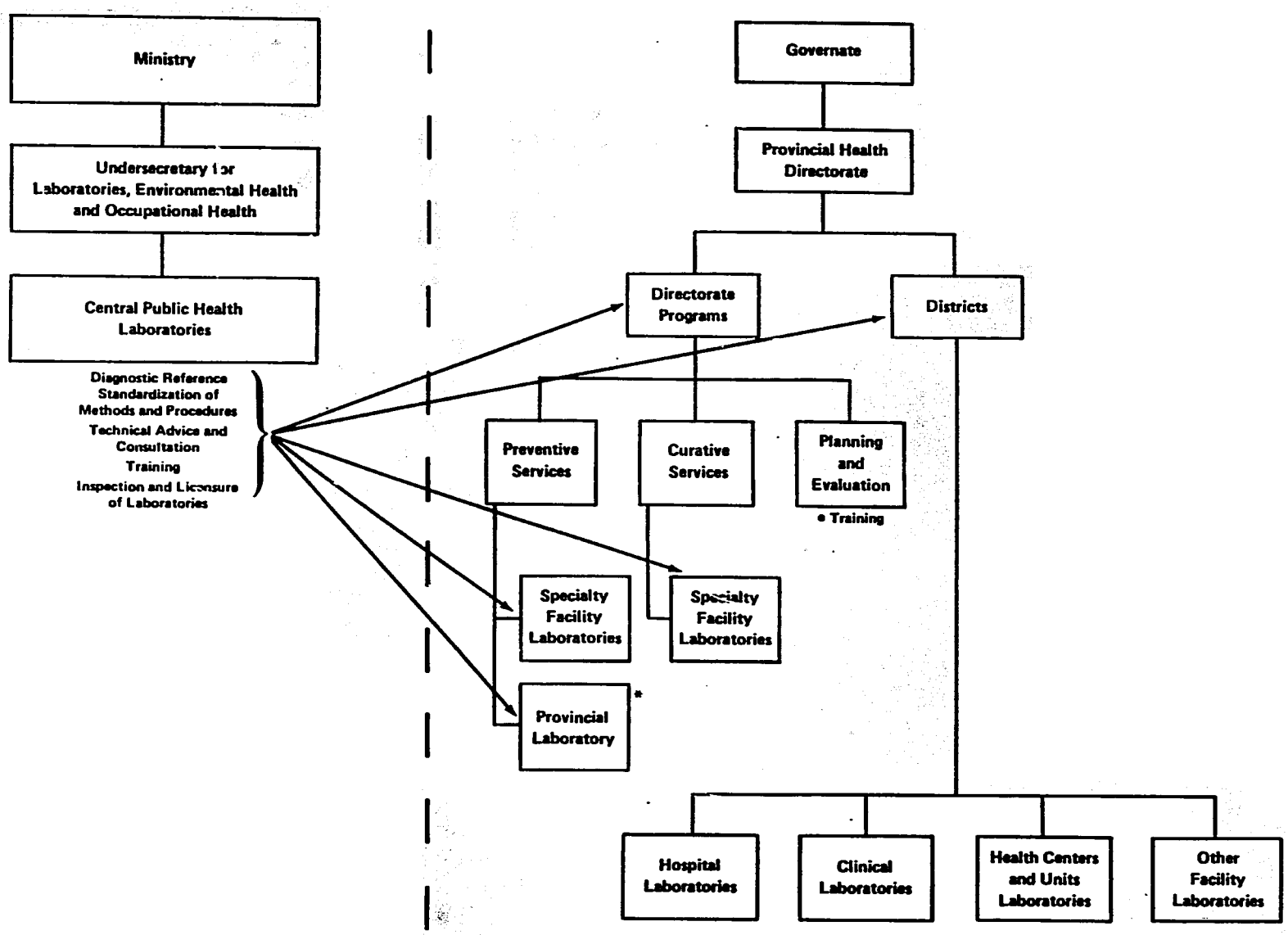
1. The present CPHL facility is housed at 19 Sheikh Rihan Street, Cairo, in an extremely old building. Under present conditions, even with some renovation that has and is being accomplished, the facility is woefully inadequate to house a laboratory function of the CPHL level. (A separate section of this report will deal with facility inadequacies and recommendations to upgrade the CPHL facility at its present location. A major constraint is the recommendation by Egyptian officials that the present CPHL facility remain at its present location.)

2. The present organization and functional responsibilities assigned as shown in Figure 3 (Page 28) are seriously incompatible with what should be done in a national public health laboratory. Most of these inadequacies are recognized by Dr. El Gamal and serious thought is being given by him and CPHL leadership as to changes needed. These major inadequacies at the present time are:

a. The CPHL does not have a reference diagnostic system for all major laboratory disciplines needed to support national disease control and epidemiological initiatives. For example, only a limited quantity of virus serology is done, no parasitological reference work is accomplished, histopathology reference work is limited in scope, and the general bacteriology reference work, though considered good, is also seriously limited.

b. Routine clinical work, in direct support of "walk-in" patients is done throughout the CPHL - especially in the clinical pathology department - and is not a generally recognized national public health laboratory function. This mixes patients with laboratory work which not only is hazardous but is seriously distracting. Furthermore, scarce facility space and resources are utilized for such a non-public health function.

FIGURE 4
Organizational Relationship of the Central Public Health Laboratories in Cairo and Governate Health Laboratories



*NOTE: The provincial laboratory at the present time is performing some diagnostic reference work for governate laboratories and also furnishing technical consultation and advice to laboratories as necessary.

c. The present water and food chemistry function is limited to routine work only. Although serving as a purely public health function, reference work or special project work for geographical problem areas, product studies, or special studies of certain industries which should be done by such a central function at the national level is virtually non-existent.

d. Training and continuing education is a major responsibility of a national laboratory such as CPHL. During the study there was no clear delineation of training responsibility as well as a planned training program for the trainees. Not only was such a written program not available but no one knew where and how many trainee personnel were in the total CPHL at any one given time. Training methodology consists of bench work observation and performance and no formal training classrooms were available. Such a methodology further taxes the crowded laboratory space available - and hinders the flow of routine work.

e. There was no evidence of epidemiological coordination between the CPHL functions which generate epidemiology data (positive results of certain reportable diseases) and epidemiologists of the Ministry's Preventive Services function. Although reports of positive laboratory findings were sent from CPHL to Preventive Services, there were no reports available for the U. S. project team containing analyses of disease trends or findings concerning certain diseases or geographical locations.

f. The receiving of specimens and samples is done on a decentralized basis. Some work to be done is brought in directly to the laboratories as well as patients sent directly to the laboratory where the specimen is to be taken. This not only is inefficient but serves as a potential biological and chemical hazard, security problem, and distraction to laboratory personnel.

g. Media preparation, glassware washing and preparation, and related work is done by the various laboratories concerned. This is considered inefficient from the standpoint of personnel utilization, space utilization, and use of equipment and materials.

h. There is no organization or system for storage control and inventory control of laboratory supplies. During the course of the study, there were many complaints concerning the availability of the proper supplies (media, chemicals, reagents, glassware, and other) at the proper time. The system for obtaining supplies as described appeared to be cumbersome and lead times were considered inordinately long. Six months to one year was considered to be the average lead time which by any standard is much too long. It was stated that to ensure proper quantities that a large supply was to be ordered each time - and in many cases - more than was needed. The storage areas that were observed appeared to be seriously inadequate in that there was no storage control system observed, supplies available appeared to be deteriorating, and the general storage areas appeared unkept and untidy.

i. Certain functions such as security and custodial functions are misplaced at the present time. Although there appears to be more than an adequate staff for custodial care, the CPHL facility is considered untidy and unkept. This not only includes the laboratories but hallways, restrooms and the entire general CPHL area. Under proper organizational assignment and supervision, the custodial and security functions could be combined to an extent to ensure better housekeeping and related functions.

j. Administrative services functions and responsibilities were not clearly delineated. No one could clearly define procurement procedures, budgetary procedures, and accounting responsibilities. The present functions appear to be delineated for budget and accounting control with some responsibility for quantifying budgets and costs, but no such data to support this function was found to be available.

3. Certain major problems stand out in relation to laboratory equipment and instrumentation. They are: Lack of standardization, the capability to adequately maintain the equipment, availability of spare parts and components, excess equipment age and obsolescence, no funds or methodology for obtaining replacement of equipment, and lack of a good general administrative procedure and organization to ensure adequate equipment maintenance. Contributing to the above problems are the great numbers of items of equipment either purchased from many different countries - each of which has differing technologies and design state of the art methodologies - or contributed by these countries. Due to this, manufacturing representatives or technicians are not always available to provide maintenance services during or after warranty periods - or provide spare parts and components. Training courses also are not available due to the many countries involved and their various political climates. Appendix I shows the CPHL equipment listing, equipment presently broken down, equipment which is critical to the laboratory operation, age of equipment, equipment in which spare parts are hard to obtain - and the great diversity of countries represented.

4. There is no set pattern or standard for determining staffing for CPHL. One reason for this is the "full-employment" policy or employee placement policy of the Egyptian government where Ministry functions appear to have to absorb certain numbers of personnel - either in full employment status or in training status. As a result of this, supervisors in CPHL could not inform the U. S. project team of their exact staffing by both category and number at a particular time. This is depicted in Tables XV and XVI. Table XV shows the various numbers by category as kept in the administrative offices of the Undersecretary. Table XVI shows the estimated staffing by each CPHL organization supervisor. Table XV more or less reveals the employment policies, and Table XVI shows a sharp difference in perhaps who and how many are employed - and in which area. Table XVI is the basis for determination of organizational and staffing requirements for CPHL organization and staffing proposals and facility requirements. Table XVII uses the data in Table XVI to produce productivity calculations for recommended staffing and proposed facility requirements. Detailed calculations which are summarized in Table XVII are shown in Appendix II.

TABLE XV

CENTRAL PUBLIC HEALTH LABORATORIES

CAIRO, EGYPT

STAFFING BY CATEGORY

Category	Total Approved Staffing	Secunded	Delegated To Other Departments	Education Leave	Special Leave	Army Duty	Deserted	Net Staffing
Medical Doctors	72	10	10	8	9	3	-	32
Chemists	105	7	15	-	17	3	-	63
Veterinarians	6	-	1	3	-	-	-	2
Biochemists	14	2	2	-	5	-	-	5
Laboratory Technicians	69	19	9	-	6	4	-	31
Laboratory Assistants	25	1	2	-	2	-	-	20
Agriculture Engineers or Agronomists	9	-	1	-	-	1	-	7
Clerks	27	-	1	-	3	-	1	22
Administrators*	23	1	1	-	3	-	-	18
Laborers	214	-	9	-	16	2	-	187
Physicians in in Training**	69	-	-	-	-	-	-	69
Total (Excluding Physicians in Training)	564	40	51	11	61	13	1	387
Total (Including Physicians in Training)	633	40	51	11	61	13	1	456

*Possibly includes personnel in administration including engineers, etc.

**Included in Table since they may be part of CPHL budget and numbers may be used to compute training facility needs.

Source: Office of Under Secretary (Dr. El Gamal)

TABLE XVI

PRESENT STAFFING - CENTRAL PUBLIC HEALTH LABORATORIES

CAIRO, EGYPT

	Number By Skill	Total By Org. Entity*
OFFICE OF DIRECTOR GENERAL		
Director General (Medical Doctor)	1	
Laboratory Administrators	2	
Clerks	2	
Laboratory Workers	2	7
ADMINISTRATION FUNCTION (Clerks & Administrators)		58
ENGINEERING FUNCTION		
Engineers	3	
Engineer Technicians	3	
Electricians	5	
Plumbers	2	
Carpenters	3	
Auto Mechanics	2	
Auto Mechanic Assistants	2	
Drivers	6	
Equipment Mechanics	2	
Blacksmith	1	
Upholsterer	1	
Foremen	4	34
LICENSURE & INSPECTION		
Administrators	2	
Clerks	3	
Laboratory Worker	1	6

*Usually denotes personnel assigned in an organizational entity or in specific laboratory space.

TABLE XVI (Cont.)

	Number By Skill	Total By Org. Entity*
MICROBIOLOGY DEPARTMENT		
Central Receiving		
Clerks	6	6
Diagnostic Reagents Section (Media Prep.,etc.)		
Laboratory Technicians	3	
Laboratory Assistants	3	
Laboratory Workers	4	10
Bacteriology Section		
TB		
Doctors (Medical & Other)	5	
Laboratory Technicians	12	
Laboratory Workers	10	27
VD and Spirochette		
Doctors (Medical & Other)	3	
Laboratory Technicians	4	
Laboratory Assistants	3	
Laboratory Workers	4	14
Virus		
Doctor (Medical or Other)	1	
Laboratory Technicians	2	3
General Bacteriology		
Doctors (Medical or Other)	6	
Veterinarians	3	
Laboratory Technicians	7	
Laboratory Assistants	4	
Laboratory Workers	4	24
Water and Food Analysis Section		
Doctors (Medical or Other)	2	
Agronomists	3	
Chemists	2	
Laboratory Technicians	6	
Laboratory Assistants	3	
Laboratory Workers	5	21

TABLE XVI (Cont.)

	Number By Skill	Total By Org. Entity*	
Water and Food Analysis Section (Cont.)			
Clerical Function (Other than receiving)		17	(122)
CLINICAL PATHOLOGY DEPARTMENT			
Biochemistry Section			
Doctors (Medical or Other)	3		
Biochemists	4		
Laboratory Technicians	5		
Laboratory Assistants	2		
Laboratory Workers	2	16	
Hematology Section			
Doctors (Medical or Other)	3		
Laboratory Technicians	2		
Laboratory Assistant	1		
Laboratory Worker	1	7	
Histopathology Section			
Doctors (Medical or Other)	4		
Laboratory Technicians	3		
Laboratory Assistant	1		
Laboratory Workers	2	10	
Clerical Function			
Clerks	4	4	
TOXICOLOGY DEPARTMENT			
Biological Fluids Section			
Pharmacists	3		
Laboratory Workers	3	6	
Food Analysis			
Pharmacists	3		
Chemists	2		
Laboratory Workers	2	7	
Clerical Function			
Clerks	2	2	

TABLE XVI (Cont.)

	Number By Skill	Total By Org. Entity*
SANITARY CHEMISTRY DEPARTMENT		
Central Receiving		
Clerks	3	3
Water Chemistry Section		
Chemists	13	
Laboratory Assistant	1	
Laboratory Workers	10	24
Food Chemistry Section (Includes color and additives)		
Pharmacists	3	
Chemists	38	
Laboratory Assistant	1	
Laboratory Workers	13	55
Clerical Function		
Clerks	3	3
TOTAL		364**

**Varies from Table XV due to variances in record keeping, employment policies, and periodic personnel reassignments and turnover. (Note 387 net positions excluding physicians in training.)

TABLE XVII

WORKLOAD, STAFFING, AND PRODUCTIVITY

CENTRAL PUBLIC HEALTH LABORATORIES

1978

Organization	Number of Specimens or Samples	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel*	Bench Time Available (Minutes)	1978 Data Productivity** Actual/Available
MICROBIOLOGY	247008	2451100	66	5940000	41
TB	11024	178811	17	1530000	12
VD and Spirochete	53815	340906	10	900000	38
Viral Serology	5583	68790	3	270000	25
General Bacti.	151662	1410932	20	1800000	78
Water & Food	24924	451661	16	1440000	31
CLINICAL PATHOLOGY	23637	322599	28	2520000	13
Biochemistry	16724	83145	14	1260000	7
Hematology	5297	35838	6	540000	7
Histopath.	1616	203616	8	720000	28
TOXICOLOGY	23908	678700	8	720000	94
Biological Fluids	7479	259410	3	270000	96
Food Analysis	16429	419290	5	450000	93
SANITARY CHEMISTRY	83462	3428249	56	5040000	68
Water Chemistry	13572	639449	14	1260000	51
Food Chemistry	69890	2788800	42	3780000	74
TOTAL CPHL	378015	6880648	158	14220000	48

*From Table XVI

**Productivity is measured by: $\frac{\text{Bench work time required (minutes)}}{\text{Bench time available (minutes)}} \times 100$ (U.S. standard times developed by CDC)

A major reason for good record keeping regarding staffing by category and organizational assignment is that such exacting data is necessary - along with cost and efficiency data - to assist the Undersecretary and CPHL management in justifying costs and personnel in the determination of laboratory requirements throughout Egypt - regardless of employment policies.

5. There is no set procedure for the receiving and processing of specimen forms that should accompany specimens received in the receiving room and the laboratories. At the present time, a specimen may be received without a form (and necessary information must be recorded on some type of form), with data written on a nonstandard form such as that used by the submittor, or on a scrap of paper. Input data such as patient symptoms, date of onset of disease, type and/or source of specimen, and other necessary data may be omitted, thus making it more difficult for the laboratory to process the specimen. In most cases submission information is manually transcribed to the proper CPHL forms by clerical and professional personnel in the appropriate laboratories. Then, more forms may be manually prepared by these personnel to include test results after copying submission data from the first manually prepared form. The above procedure is not only time consuming and costly, but provides a chance for error in data from submission and test examination sources. Then, too, the retrieval of data for submission to the epidemiology function and for work count and planning purposes becomes more difficult.

6. There was no cost and efficiency data available so the U. S. project team could determine actual costs and work efficiency. Such data is necessary if a methodology is to be provided for estimating and justifying future laboratory needs at all levels. Appendix II shows calculations regarding workload and staffing by CPHL organizational entity at the lowest level possible. Table XVII, as previously mentioned, summarizes these data and provides productivity calculations. A system for determining cost and efficiency is provided further in this report.

7. As noted in Table XI, there is a shortage of trained laboratory personnel throughout Egypt - especially in the areas of Microbiology and Laboratory Technician. One way that the CPHL and laboratories in the provinces have alleviated this shortage has been to utilize doctor-level personnel at the technician level. Most of the work being done at the CPHL - including diagnostic reference work can be accomplished by less than doctoral-level professional personnel and technicians. This can easily be seen when the procedures presently used are analyzed as to skills needed. It should be noted, however, that doctoral-level personnel must be available to supervise, lead research, teach, perform proficiency testing and quality checks on laboratory personnel, and perform the more sophisticated and complex testing. During the U. S. project team's visit, it was noted that training institutes to alleviate shortages of technicians and laboratory assistants are being set up in various provinces. Gharbia - from the U. S. project team's observations - now has an excellent nucleus for training such laboratory personnel.

In regard to the above, it is recommended that:

1. Facility plans for CPHL as outlined in a separate section of this report, be implemented as quickly as possible.

2. The Undersecretary for Laboratories, Environmental Health and Occupational Health institute the following changes - with Ministry assistance where necessary - in CPHL organization and functional responsibilities:

a. Establish policies, procedures, and inter-governate communications whereby the CPHL will be given the mandate and resources to become the focal point for all laboratory activities in Egypt. This involves:

(1) The establishment of CPHL as a national diagnostic reference center.

(2) The performance of special diagnostic public health activities relating to disease control and epidemiology not done in the provincial laboratories.

(3) The CPHL as a national center for policies and evaluation of needs for training and consultation. The CPHL would also provide training facilities and professional consultation to provincial health organizations.

(4) The technical supervision over provincial laboratories regarding:

(a) Standardization of methods, procedures, and equipment.

(b) Inspection and licensure of laboratories.

(5) Research activities (basic and applied) where needed.

(6) Evaluation of effectiveness of delivery of laboratory services at all levels in Egypt.

(7) The establishment of a data center for all laboratory and related data throughout Egypt (skills, number and location of laboratories, methodology used, equipment used, numbers of personnel by skill, number of specimens and tests accomplished by result, budgetary and cost relationship, productivity calculations, laboratory requirements, etc.). A small minicomputer could be used in this center after the initial data assimilation - especially for the many varied calculations and the periodic input of data. Data input from the provinces should be handled by mail, however, since more advanced modes of communication are not feasible at the present time.

b. Establish and appoint a senior administrative position called "Director of Administrative and Scientific Services." This major

entity would consolidate all administrative and scientific functions which serve the CPHL's scientific community. A major advantage is that greater attention and quick response would be forthcoming to laboratory personnel from a high level in the CPHL organization. Furthermore, more effective personnel utilization and supervision can be accomplished by this organization. In summary the changes are:

(1) Place all administrative services presently being done in the office of CPHL (personnel, budget and accounting, procurement, certain clerical, and statistics) under the Director as an entity.

(2) Transfer custodial and security functions to Engineering. A major advantage is the good possibility of further cross-utilization of personnel and closer supervision. Engineering would now become Engineering Services and report directly to the Director.

(3) Combine all receiving, glassware preparation, proposed animal quarters, and storage and inventory control of laboratory supplies under an entity called "Scientific Services." The head of this entity would report directly to the Director.

(4) Establish an entity called "Training and Continuing Education Coordination" reporting directly to the Director. This function would entail operating a training laboratory, keeping training records, providing advice to the Director and appropriate CPHL personnel as to training needs throughout Egypt, responsibility for lecture room and library, and maintaining skills and other statistics.

c. Establish a major entity called "Epidemiology Liaison" to ensure the CPHL's direct involvement in epidemiological field studies and employment of appropriate laboratory personnel as required during outbreaks and special studies. This entity would also provide the Ministry epidemiology function with appropriate laboratory data on a periodic and timely basis. This, in essence, establishes a partnership between the CPHL and the Ministry's epidemiological function - and this is as it should be.

d. Establish separate and distinct CPHL departments for virology and parasitology so as to provide the necessary public health laboratory reference programs in order to support all the Ministry's disease control initiatives and governate laboratories. Such programs are deemed necessary due to the disease problems prevalent throughout Egypt both daily and on a seasonal basis. In turn, such expertise is needed at the national laboratory level to carry out the "focal point" policies recommended above. Furthermore, Ministry functions in virology and parasitology performed elsewhere should be centralized in the CPHL to provide the program impetus necessary and save scarce and very expensive resources now being duplicated in various organizations throughout Egypt. For example, after a short visit to the Agouza Vaccine Institute, it was noted that a virus diagnostic

function was being carried out in the same building where vaccines are being produced. A serious possibility exists in this situation since there is a distinct chance for cross-contamination problems. In the opinion of the U. S. project team, virus diagnostic work should not be accomplished in the same facility with vaccine production. This function should be appropriate for transfer to the CPHL. The minimum services that should be included under these two major new CPHL Departments are listed under the proposed CPHL organization and functions chart.

e. Establish a General Bacteriology Department in lieu of the present Microbiology Department. This department would be divided into six divisions and are shown in the proposed CPHL organization and functions chart. Primary additions recommended for the bacteriology program are:

(1) Add a leprosy activity to the tuberculosis activity, and call the activity Mycobacteriology.

(2) Add a gonorrhea program to the syphilis activity and call the activity Venereal Disease - an activity surely to increase as the Egyptian economy expands and contacts with the outside world increase.

(3) Establish a Miscellaneous Pathogens activity and add a mycology and rickettsia activity in this area to support the public health reference work necessary throughout Egypt.

(4) Combine and centralize diagnostic reagent and media preparation work.

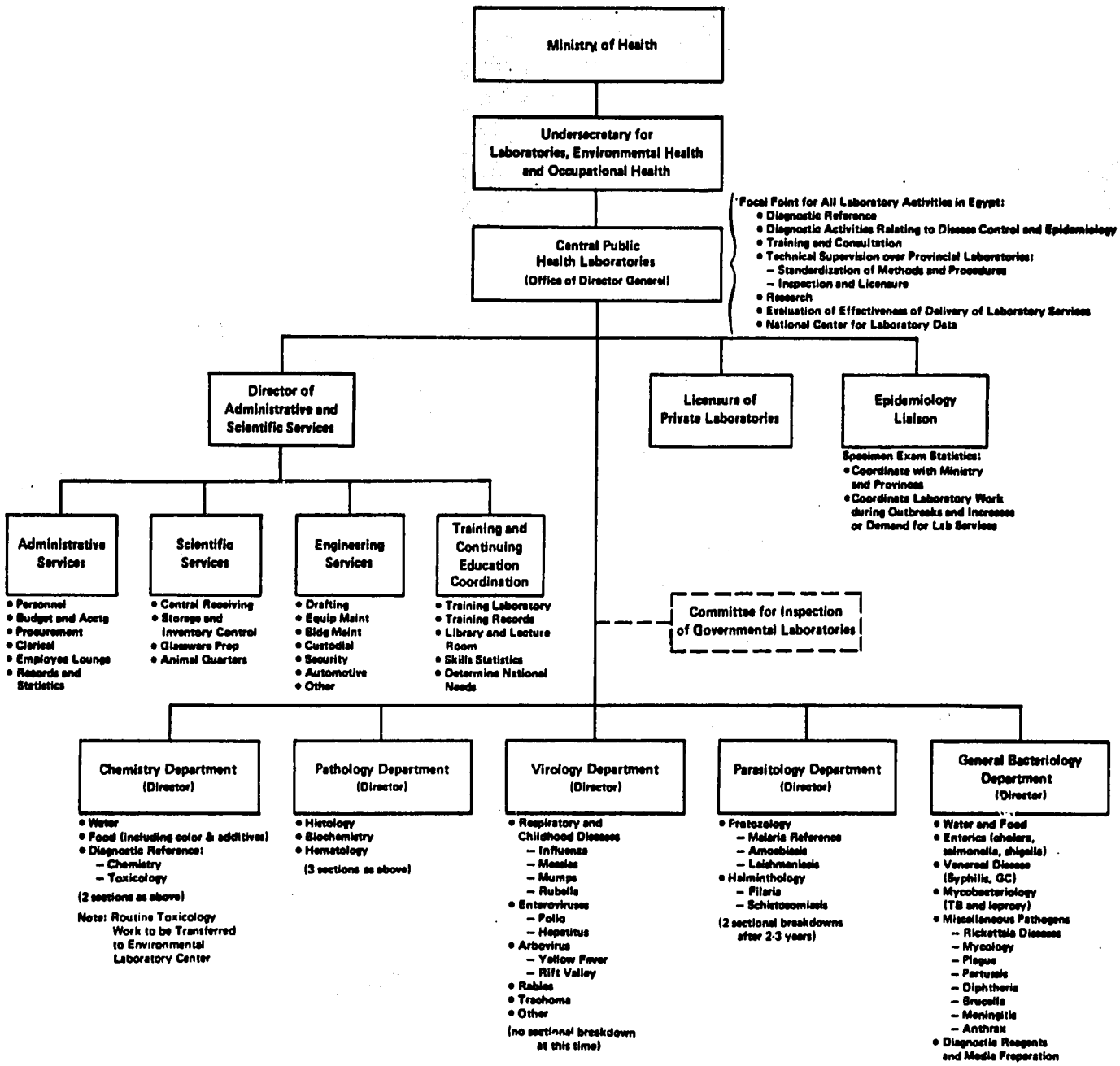
The above proposals are shown in the proposed CPHL organization and function chart.

f. Discontinue routine laboratory services for patients presently done in the Pathology Department and ensure the transfer of this work to local laboratories. Establish a strong reference diagnostic function in histopathology.

g. Consider transfer of routine water and food chemistry laboratory work to the new Environmental Laboratory Center. (It was decided prior to the U. S. project team's visit that the Toxicology function will be transferred to the new Center.) Continue reference work at CPHL for water and food chemistry and in support of epidemiological and disease control initiatives. Some toxicology work such as that related to public health problems should also be accomplished at the CPHL although other toxicology work is planned for the new Environmental Laboratory Center. This can be done in the proposed Chemistry function.

The above changes are all depicted in Figure 5.

FIGURE 5
Proposed Organization and Functions of Central Public Health Laboratories Cairo, Egypt



3. Consider the proposed staffing plan shown in Table XVIII for the organizational changes shown in Figure 5. This proposal should not be considered as a personnel cutting proposal, but as a planning proposal for facility renovation purposes. If total staffing - under present employment policies - were utilized for facility planning, renovation costs would be prohibitive.

4. The Undersecretary for Laboratories, Environmental Health and Occupational Health institute the following changes in administrative and management practices which should provide for greater efficiency and effectiveness of overall laboratory operations as well as better support and response to the scientific community:

a. Immediately begin a program for laboratory equipment and instrumentation standardization and maintenance which involves the following:

(1) When replacing equipment and instrumentation, ensure that purchases are made from sources where spare parts and components will be easily available over a long period of time and economical training courses on warranty services are available, and source representatives are available in case of inquiry or problems. Whenever possible, such items should be purchased from as few sources as possible - and from that source with the best reputation for technological development of laboratory equipment and instrumentation.

(2) Implement a preventive maintenance system as outlined in Appendix III which will contain a number of publications of administrative and management techniques. The U. S. Project Officer will further assist CPHL and the Engineering Services function which is responsible for the maintenance function in the above implementation.

b. Implement a storage and inventory control system for laboratory supplies as outlined in Appendix III. An additional technique for simplification and standardization of laboratory supplies is also presented. The U. S. Project Officer will assist in this implementation during his next visit.

c. Incorporate the following changes in the receiving and processing of specimen forms:

(1) Redesign forms so that:

(a) A form is available for use in each major discipline or disease category to be submitted with each specimen.

(b) Space is available on one form for all submission, processing, and report data.

TABLE XVIII

PROPOSED STAFFING - CENTRAL PUBLIC HEALTH LABORATORIES

CAIRO, EGYPT

Function	Present Staffing	Present Efficiency	Proposed Staffing	Remarks
GENERAL BACTERIOLOGY DEPT.		-	1	Supervisory office required.
Clerical Support	17	-	5	For records and reporting only.
DIAGNOSTIC REAGENTS & MEDIA PREPARATION	6 (+ 4 workers)	-	6 (+ 4 workers)	No supervisory office necessary.
MYCOBACTERIOLOGY (TB & Leprosy)	17 (+ 10 workers)	12	6 (+ 5 workers)	Less personnel and space requirements due to low efficiency.
VENEREAL DISEASE (Syphilis & GC)	10 (+ 4 workers)	38	10 (+ 4 workers)	Staffing same due to adding of GC and other VD work. Small office space required for section supervisor.
MISCELLANEOUS PATHOGENS	17 } (+ 4 workers)	78	16 } (+ 4 workers)	Small office space req'd for section supv.
ENTERICS	3 }		4 }	Small office space req'd for section supv.
WATER & FOOD	16 (+ 5 workers)	31	16 (+ 5 workers)	Small office space req'd for section supv. and staffing - same for growth potential.
PARASITOLOGY DEPARTMENT	-	-	3 (+ 5 workers)	Small office req'd for Department supv.
Clerical Support	-	-	2	
VIROLOGY DEPARTMENT	3*	25	5 (3 virologist) (+ 2 techni-) (cians)	Small office space for Department supv.
Clerical Support	-	-	2	(Presently doing viral serology in Microbiology function.)
PATHOLOGY DEPARTMENT	-	-	1	Supervisory office required.
Clerical Support	4	-	3	
Biochemistry	14 (+ 2 workers)	7	4 (+ 2 workers)	Most of work done should not be done in CPHL.
Hematology	6 (+ 1 worker)	7	4 (+ 1 worker)	Most of work done should not be done in CPHL.
Histopathology	8 (+ 2 workers)	28	8 (+ 2 workers)	To ensure a good histopathology reference function.
TOXICOLOGY DEPARTMENT	8 (+ 5 workers)	94	-	To be transferred to Environmental Center so no space requirements necessary.
Clerical Support	2	-	-	

TABLE XVIII (Cont.)

Function	Present Staffing	Present Efficiency	Proposed Staffing	Remarks
CHEMISTRY DEPARTMENT	-	-	1	Supervisory office required.
Clerical Support	3	-	3	For records and reports.
Water	14 (+ 10 workers)	51	14 (+ 10 workers)	Staffing remains same for growth potential.
Food	42 (+13 workers)	74	42 (+ 13 workers)	Staffing remains same for growth potential.
				(Both sections above should eventually be transferred to new Environmental Center.)
DIRECTOR OF ADMINISTRATIVE & SCIENTIFIC SERVICES	-	-	1	Supervisory office required.
Clerical Support	-	-	3	
TRAINING & CONTINUING EDUCATION COORDINATION	-	-	1 (+ 2 clerks)	Small supervisory office required plus training laboratory. Library and conference room should be combined.
ENGINEERING SERVICES	34	-	-	Need small office space for supervisor.
SCIENTIFIC SERVICES	-	-	1	
Clerical Support	-	-	1	
Central Receiving	9 (Microb. & Chem.)	-	9 clerks	Combined microbiology & chemistry receiving.
Storage & Inventory Control	Included in other functions.	-	5 clerks	Central function for storage & inventory control.
Glassware Prep.	-	-	10 workers	Space left for automatic washers in future.
Animal Quarters	-	-	2 workers	Holding facility only.
ADMINISTRATIVE SERVICES	-	-	1	Supervisory office required.
Personnel	58 clerks, administrators, & workers	-	6	
Budget & Accounting		-	6	
Procurement		-	5	
General Clerical		-	22 (+ 18 workers)	
Employee Lounge	-	-	-	
LICENSURE OF PRIVATE LABORATORIES				
Supervisor	1	-	1	Need office for supervisor.
Clerks & Adm.	4 (+ 1 worker)	-	4 (+ 1 worker)	
EPIDEMIOLOGY LIAISON	-	-	1	1 Epidemiologist with private office.
Clerical Support	-	-	1	

TABLE XVIII (Cont.)

Function	Present Staffing	Present Efficiency	Proposed Staffing	Remarks
OFFICE OF DIRECTOR GENERAL (CPHL)	1	-	1	1 Director General Office
Secretarial	-	-	2	
Clerks & Administrators	4	-	4	
Workers	2	-	2	
TOTAL PERSONNEL	364		321	

(See Table XVI)

NOTE: Space requirements and facility plans derived from proposed organization, staffing, and computed efficiency. If space available in those areas where staffing cuts are recommended due to workload efficiency, then additional space will be added.

(c) They are of multiple copy design and will suffice for submission, processing and reporting purposes thus eliminating unnecessary copying or reproducing by professional and clerical personnel.

(d) They can be used in laboratories at all government levels. Such standardization, especially for the provinces, should greatly reduce printing costs, provide for uniformity in submission and reporting, and provide for uniform data retrieval procedures.

(2) Change present processing procedures so that:

(a) Forms will be properly filled out prior to receipt of specimens in receiving room. If form is not filled out properly, ensure that submittor or person(s) delivering specimens fill out all appropriate information on the form prior to acceptance of the specimen.

(b) Forms will accompany specimens to laboratory where results will be recorded on forms. Forms will then be forwarded to a clerical area where one copy will be removed for reporting purposes and one copy filed as the laboratory record. If an additional copy is necessary for epidemiology purposes, a copy can then be machine reproduced. (An alternative to this approach is to provide a single copy form and reproduce one or more copies for distribution.)

Suggestions for design and processing and copies of consultation done in this area will be sent to Dr. El Gamal in a separate package from this report. Implementation of the above recommendations should provide substantial savings in clerical work as well as a more useful and practical procedure for processing specimens.

d. Implement a work efficiency or productivity scheme which will assist in determining workload status, staffing requirements, and needs for shifts in personnel with skills in short supply from one laboratory organization to another - especially during seasonal workload fluctuations, epidemiological studies, or for purposes of training. Table XVII (Page 38) is a case in point of use of such a scheme.

Table XVII shows the results of productivity calculations for CPHL for 1978. Several sets of personnel staffing data and several sets of workload data for 1978 were supplied to the study team. Unfortunately, it was impossible to reconcile the different sets of data. What is emphasized in Table XVII is the results of a methodology. The methodology for calculating productivity is described in detail in Appendix II. Cognizant officials at the CPHL can develop similar

productivity calculations for future years using properly documented workload and personnel data. Detail calculations for Table XVII are also shown in Appendix II. The last line of Table XVII shows the productivity calculation (48) for all of the CPHL. This is called the laboratory average productivity. Each department productivity is shown in the major headings (e.g., Microbiology is 41, Clinical Pathology is 13, Toxicology is 94, and Sanitary Chemistry is 68). The next major headings are the productivity calculations for each section within each department (e.g., Tuberculosis is 12, Biochemistry is 7, Food Analysis is 93, and Water Chemistry is 51).

Of significance is that in such calculations the goal is to be as close to 100 as is possible. However, a target of 80 should be used as a signal that some type of management perusal or analysis may be necessary as to why the productivity rate is getting closer to 100. This could signal the need for additional personnel requirements as the rate approaches or exceeds 100. Then, too, it could mean that too much routine work is being accomplished, or the work count is erroneous. If the productivity calculation is considerably lower than 80-100 as shown, for example, in Table XVII for Clinical Pathology (13), then management may decide after careful perusal that Clinical Pathology is considerably overstaffed or that additional workload should be added to the function. In regard to the 80-100 calculation, Table XVII shows that Toxicology has attained a calculation of 94. This indicates that an additional laboratory person may be needed as the calculation reaches or exceeds 100. This is usually the case. However, management should also determine if too much routine work is being accomplished, or accepted, if the work count is erroneous, or if a different procedure is being used from that which the productivity standard is based. Another possibility is the transfer of qualified personnel into Toxicology from an organization with a much lower productivity calculation, as for example, Clinical Pathology (13) or Sanitary Chemistry (68).

e. Implement a system for determining costs per laboratory tests as outlined in Appendix III. This methodology not only can be used in the CPHL, but in Provincial laboratories, hospital laboratories, and laboratories at other levels when deemed necessary. The calculations from this methodology should provide data for:

(1) Budget and program planning.

(2) Cost trends to compare with efficiency or productivity indicators.

(3) Comparison of costs among all laboratories by type in all provinces.

(4) Determination if programs and/or tests are too costly and should be eliminated, combined, or done elsewhere.

f. Implement a system for determining service levels in clinic and hospital laboratories throughout Egypt. Such a system should determine tests that should or should not be done in a specific facility with the following results:

(1) Unnecessary duplication of services among clinics and hospitals in close proximity would be prevented.

(2) Equipment and material costs should be considerably lower with resultant savings used toward those facilities with the greatest needs.

(3) Less demand for advanced skilled personnel and such personnel could be used more efficiently.

(4) Training costs would be lowered - as well as related administrative costs of maintenance of equipment and procurement of materials.

The methodology for this sytem is shown in Appendix III and will be more fully explained during the next visit of the U. S. Project Officer. This methodology has been used with success in hospital laboratories in the United States. The same principles apply, however, in laboratories like that of the CPHL, the Tanta laboratory, and provincial facility laboratories.

GHARBIA PROVINCE - GHARBIA HEALTH DIRECTORATE

The Gharbia Health Directorate carries out all health services as planned by the Ministry. These services, funded by the Ministry, are carried out with full autonomy by the Directorate. In addition to the significance of this autonomy, the Directorate provides input periodically to the Ministry as to the health needs of the Province and such input ensures the Ministry that its goals and objectives of providing adequate health services to all citizens are met. The Directorate's primary aim is to ensure that health services are available on a provincial or community-wide basis for all citizens, and that these services are immediately accessible. A summary of the Directorate's goals and objectives are:*

1. Plan health services relevant to community health problems and specifying priorities according to community needs. The community itself may express its needs and these are taken into consideration by top Directorate officials.

2. As mentioned above, a primary objective is to make health services accessible to all.

3. Provide the proper staff, equipment, and organization to meet health demands.

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*Source: Gharbia Health Directorate Officials

4. On a continuing basis, define the types and numbers of physicians, nurses, and other health workers to be trained to meet the needs of the Province.

5. Utilize on an optimum basis those health personnel trained for specific health work. Ensure feedback of information to top Directorate officials as to this utilization.

6. Operate a training institute to fulfill the needs for trained health personnel. Of special significance is that the Gharbia Health Directorate operates one of the five health training institutes in Egypt for training laboratory technicians and laboratory assistants. Such trained manpower is necessary to ensure that personnel manning laboratory positions are not over-qualified and that laboratory personnel are properly utilized.

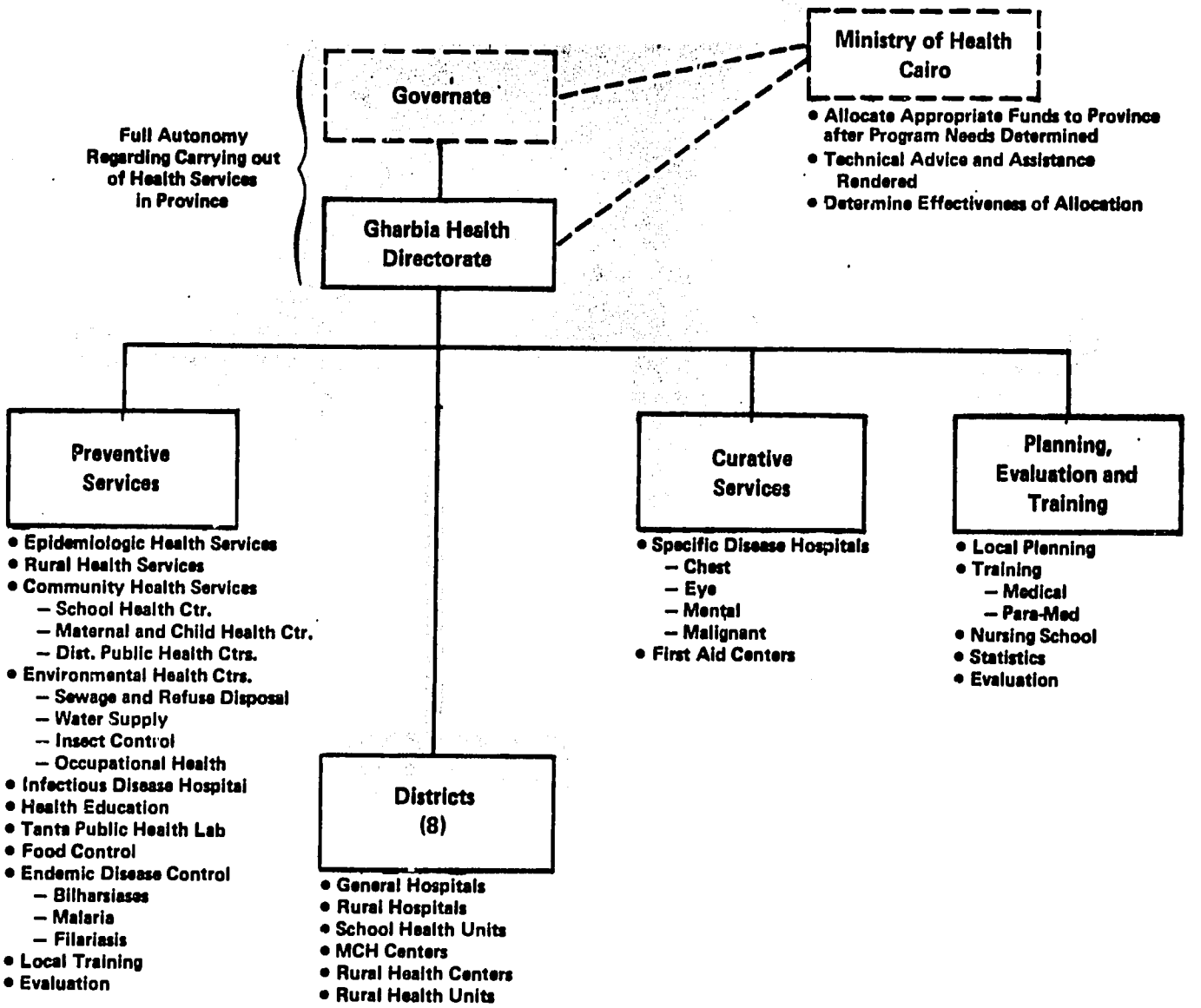
The organization and functions of the Gharbia Health Directorate are shown in Figure 6. For the most part, the U. S. project team was told each governate health function is organized similarly and this chart can be considered as representative for the 25 Provinces in Egypt.

During the study, the U. S. project team surmized that the Gharbia Province Health Directorate was one of the better organized, staffed, and better functioning, because of its important geographical location in the center of the agricultural and industrial area of the Nile Delta. This was due, it was felt, to the enormous respect that Dr. Nasr Diab and his staff enjoy throughout all provincial health facilities that were visited. It was readily apparent that Dr. Diab and his staff were - with all the budget and other constraints that are prevalent in such an organization - carrying out to the fullest the intent of Ministry and Provincial health goals.

It was also found that Dr. Diab understood the need for good laboratory services and that these services closely interrelated with all Directorate programs. Therefore, the U. S. project team felt that in order to improve laboratory services throughout the Province close perusal of Directorate programs (Preventive Services, Curative Services, District Organizations, and Planning Evaluation and Training - see Figure 6) must be accomplished. Similar organizational and policy problems were found in the Directorate programs as are discussed in the section of this report dealing with Ministry organization and functions as they apply to laboratory services. These problems are:

1. There is an extensive overlap of program responsibilities which require or generate laboratory services throughout the Province. For example, laboratory services are both generated and accomplished in eight districts, each of which is autonomous and report directly to the Health Directorate, the Preventive Services program which administers preventive health services as well as containing health facilities which have laboratories, and the Curative Services program which administers curative health programs as well as containing health facilities which have laboratories. More specifically, a general hospital in each district is concerned with both preventive and curative aspects, specific disease hospitals under the Curative programs must perform laboratory tests related to both curative and preventive aspects. The type of facilities located under each program area are shown in Figure 6.

FIGURE 6
Present Organization and Functions – Gharbia Health Directorate



Source: Gharbia Health Directorate Officials

2. There is no clear delineation as to responsibilities for determining laboratory priorities, if duplication or overlap of services exists, where and if certain procedures should be accomplished, and if all laboratories meet the needs of the Province's health delivery system. A single organization to perform these responsibilities does not exist. There is an excellent nucleus - and a similar situation was discussed regarding the Ministry organization - for such a single organizational responsibility and this presently exists under the provincial laboratory located in Tanta and headed by Dr. Elias Dib Aziz, one of the most respected and knowledgeable clinical pathologists in Egypt. This laboratory which, as previously mentioned, serves both curative and preventive aspects in the Province is presently organizationally located under the Preventive Services program of the Directorate.

3. Many specialty and other health facilities requiring laboratory services are - in the opinion of the U. S. project team - obsolete. As previously discussed in the section of this report dealing with the Ministry organization and functions, this imposes a drain on not only the health budget of the Province but on needed laboratory services.

In the above regard, it is recommended that:

1. Dr. Diab give serious consideration to realignment and reassignment of health program responsibilities in order to:

a. Eliminate overlap in regard to program areas and facility supervision. All physical facilities delivering health care to patients located in each district should be placed under the supervision of the particular district director. This includes specialty health facilities presently under the Preventive and Curative Program functions. Such a realignment would place in much greater perspective the need to eliminate obsolete facilities and the provision of more effective services in each district. Efficiency of delivery of health services for each health facility and total district can be measured, and then district comparisons can be made. This provides further autonomy and an incentive to provide better care at less cost.

b. More clearly define program responsibilities. In the Preventive Services, Curative Services, and Planning Evaluation and Training programs, such program functions as program coordination, determination of program requirements, evaluation of program effectiveness, and administration of specific programs should be stressed, and program supervision held fully accountable for the carrying out of the program as assigned.

c. Provide a single central authority and organizational entity to determine provincial laboratory requirements and effectiveness of delivery of these requirements. The nucleus for this entity - as previously discussed - is presently located under the Preventive Services program as the Tanta Public Health Laboratory. This entity should serve as a separate program under the Gharbia Health Directorate and be called the Provincial Laboratory. (A recommended program is

discussed under the next section of this report dealing with the Provincial Laboratory.)

2. Dr. Diab and his staff assess the efficiency and effectiveness of certain specialty or specific disease facilities which overlap and in some cases duplicate health delivery services presently accomplished in general hospitals and related facilities. It is the opinion of the U. S. project team that services presently rendered in the Province's chest, malignant disease, eye, and infectious disease facilities can be effectively consolidated with services rendered in hospital facilities, thus providing optimum use of scarce health funds and laboratory resources. Dr. Diab should serve as a member of the commission for determining such effectiveness and consolidation as recommended in the section of this report dealing with the Ministry of Health.

A proposal to incorporate the above changes in organization and functions is shown in Figure 7. In summary these changes provide:

1. A separate and distinct entity called the Provincial Laboratory. Functions as shown will be discussed in the next section of this report dealing with the Provincial Laboratory.

2. Assignment of all health facilities to districts in which they are located. (It is assumed that eventually a number of these facilities may be consolidated or declared obsolete.)

3. Further clarification of major functions that should be assigned to the Preventive Services and Curative Services programs. Primary responsibilities of epidemiological coordination, determination of health services requirements, evaluation of program effectiveness, and other specific program areas of administration as assigned should be more than sufficient, as well as all inclusive, to fulfill the Health Directorate's objectives of providing health services to all citizens of the Province on an individual community basis. The functions as assigned in Figure 7 are self-explanatory.

4. A change in organizational nomenclature of the Planning, Evaluation and Training program to Health Education and Evaluation. Since health education and related training activities comprise the preponderance of this program, Health Education and Training functions presently under the Preventive Services program should be transferred to this entity in order to consolidate all related programs, better utilize funds and resources assigned to such programs, and provide the necessary attention and impetus to the very important training and continuing education aspects of the country's and province's health system. The evaluation aspects should be on an inter-program basis and coordinated with the three other program areas. Overall program evaluation should be done by each of the three other programs: Provincial Laboratory, Preventive Services, and Curative Services. The functions, as assigned in Figure 7, are considered self-explanatory.

FIGURE 7
Proposed Organization & Functions — Gharbia Health Directorate

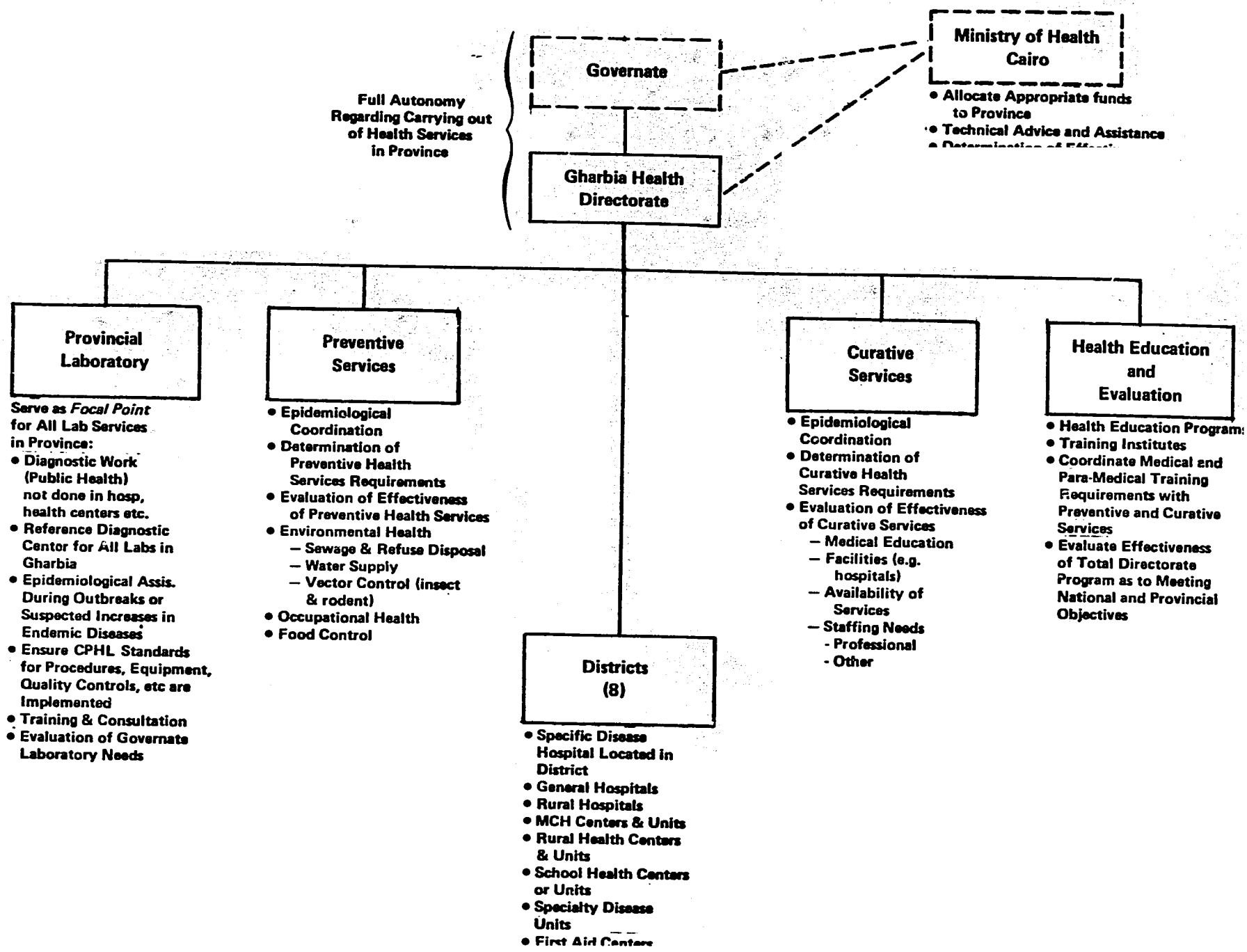
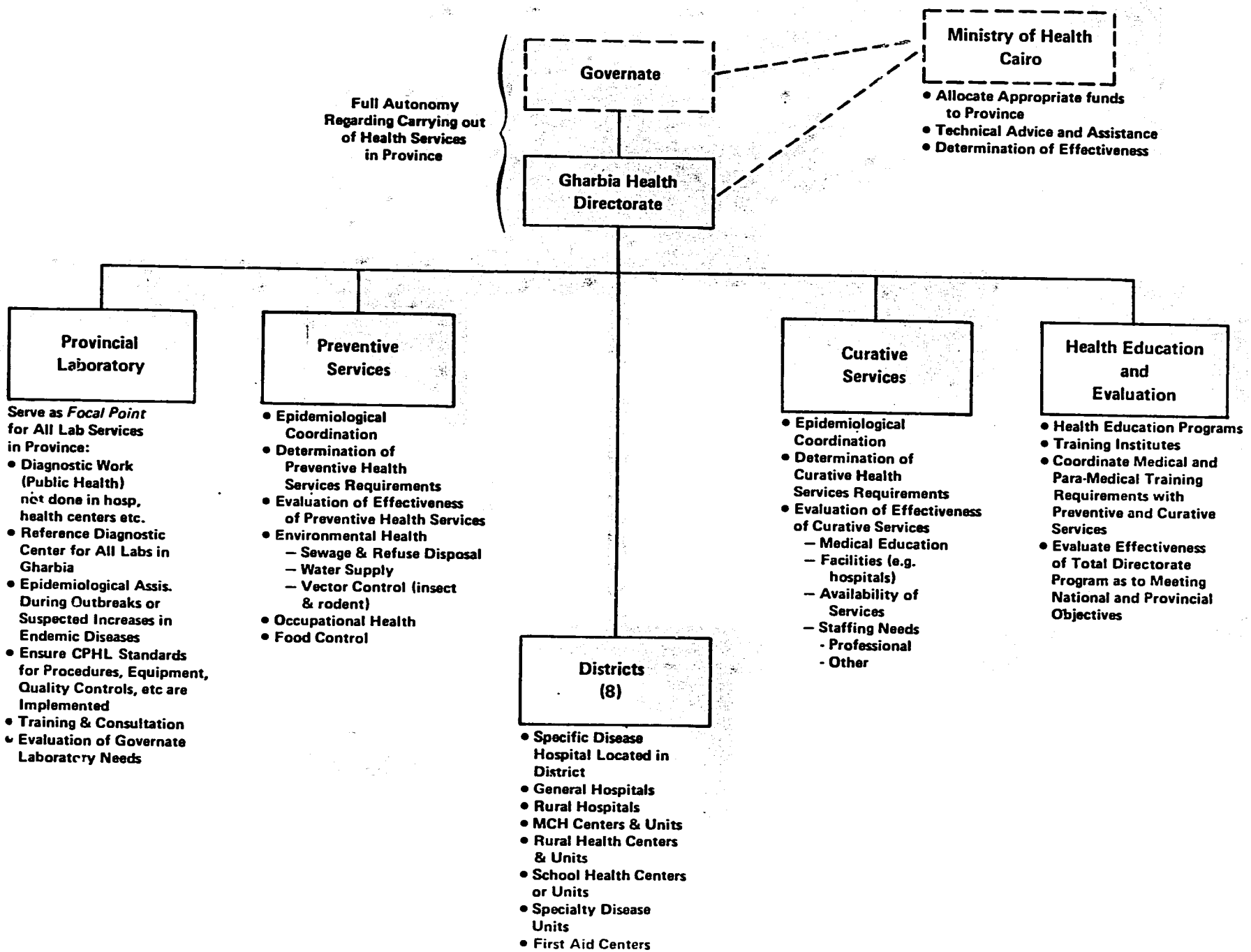


FIGURE 7
Proposed Organization & Functions — Gharbia Health Directorate



PROVINCIAL LABORATORY

At the present time, the public health laboratories in both Tanta and Mehalla serve as provincial public health laboratories. The Tanta laboratory, however, is considered the primary provincial laboratory, due to its central location in the province and in the provincial capital of Tanta. In turn, Dr. Elias Dib Aziz, the Director of the laboratories at Tanta, is considered as the foremost authority in the province regarding laboratory methodology, quality control, equipment needs, personnel qualifications and needs, and other related aspects. His laboratory, in general, serves the province in the areas of epidemiological and disease control support, environmental monitoring, food control, training, and diagnostic testing in support of those facilities (hospitals, health centers and units, and specialty facilities) not performing particular laboratory tests - or not capable of performing certain tests.

The present organization, general functions (testing areas), and staffing of the Tanta provincial laboratory is shown in Figure 8. Since the U.S. project team considers the laboratory in Tanta as the principal provincial laboratory, the laboratory in Mehalla will not be discussed in regard to its organization, functions, and staffing.

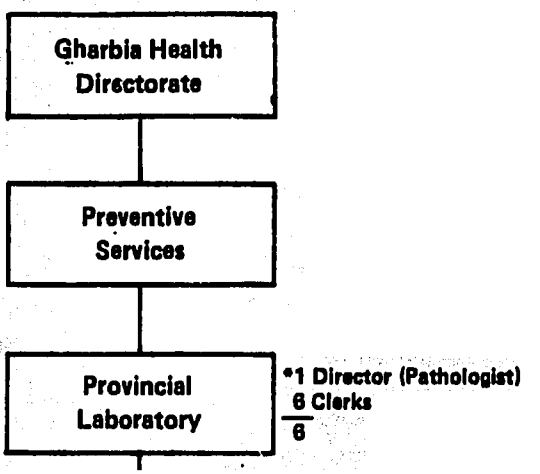
As discussed in the previous section of this report regarding the Gharbia Health Directorate, Dr. Diab recognized the need for good laboratory services, and that these services interrelated with all Directorate programs. He also recognized that certain problems in the delivery of laboratory services exist due to national policy, provincial health organizational structure and budgetary constraints. These problems discussed with both Dr. Diab and Dr. Elias Dib Aziz are:

1. As discussed in the previous section of this report, there is no single authority or focal point for determining laboratory requirements and effectiveness in the province, and this poses as a serious weakness in the provincial health delivery system.

2. The present organization of the Tanta laboratory and the functions assigned are seriously incompatible with the needs and demands of a provincial laboratory. For example, the laboratory does not offer reference diagnostic services needed to support provincial health facilities which have incidences of common infectious diseases such as hepatitis, viral encephalitis, viral pneumonia, the common viral diseases of children, malaria, amebiasis, Rift Valley fever, etc. In turn, the laboratories at these facilities are inadequate to handle the necessary laboratory services to support the medical staff and provide good medical care for the patients. Occasionally, however, with extraordinary effort and expense, a laboratory team from Cairo - in some cases from the Agouza Institute and some from CPHL - will, upon request by provincial facilities or the provincial health authorities - collect, transport, and analyze appropriate specimens. This is not only inefficient, but delays testing results and severely limits the quantity of laboratory services needed on both a special and a routine basis throughout the province. Furthermore, certain other tests that should be done for routine disease control and epidemiological initiatives are not offered - for example - gonorrhea. Histopathology services, both for routine and

FIGURE 8

Present Organization, General Functions, and Staffing — Provincial Laboratory — Tanta



diagnostic reference purposes, are woefully inadequate throughout the province, and the Tanta laboratory offers only very limited support for such services through the fine cooperative effort and individual initiative of Dr. Elias Dib Aziz. Finally, certain needed laboratory procedures in support of national environmental health programs in the area of water and food chemistry are not done due to the need for special equipment or apparatus, facility layout, and expendable supplies. Qualified personnel (20 chemists) are available to perform such tests.

3. Certain routine procedures in direct support of patient treatment are being performed in the Tanta laboratory. This is a function compatible with health treatment facilities, and not one that should be done solely in a provincial laboratory. (See discussion regarding CPHL work in this area.) It is recognized, however, that a certain amount of such testing may be necessary for training of laboratory personnel and diagnostic reference purposes.

4. The laboratory facility at Tanta - although well kept from the administration and housekeeping standpoint - is considered inadequate in regard to overall space needs, biological and chemical safety requirements, procedural needs, and layout. This will be discussed further in the section of this report dealing with facility planning.

5. The administrative and management inadequacies present in the CPHL in Cairo are to some degree present in the Tanta laboratory. These relate to:

a. Staffing. The Tanta laboratory appears to be under the same "full employment" mandate as CPHL and other governmental organizations. This is evident in Tables XIX and XX where work efficiency, as computed, is very low in the water chemistry and clinical pathology functions. This shows that Tanta has an excess of personnel in these two functions as well as an excess of skills, especially chemists. In turn, Figure 8 (Page 56) shows an apparent excess number of clerical and laborer personnel in all functions which were not included in the efficiency calculation. Such excess poses a problem in the areas of space requirements, both administrative and scientific space, in terms of what is being done now and what should be done in the future. In this regard, staffing for program additions will include present staffing (in numbers - and not skills).

b. Equipment maintenance and standardization. The Tanta laboratory must rely on the CPHL engineering function for maintenance. The lack of immediate response due to the distance that repair personnel must travel from Cairo, the lack of proper skills in Cairo, and Tanta, for repairing equipment, and the lack of spare parts for the varied numbers of items of equipment purchased or received as grants from many various countries, prevent the Tanta laboratory from both utilizing laboratory equipment properly as well as providing the necessary response in support of the provincial health system.

c. The system for obtaining, storing, and issuing of laboratory supplies needs improvement. There was no set procedure to determine

TABLE XIX

WORKLOAD, STAFFING, AND PRODUCTIVITY
(WORK EFFICIENCY)

TANTA LABORATORY

1978

Organization	Number of Specimens of Samples	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel*	Bench Time Available (Minutes)	1978 Data Productivity** Actual/Available
BACTERIOLOGY	145308	793944	12	990000	.80
WATER	774	53924	10	900000	.06] .45
CHEMISTRY (FOOD)	22606	792920	11	990000	.80
CLINICAL PATHOLOGY	1975	12984	4	360000	.04

NOTE: Computed using methodology in Appendix ** and as done for CPHL.

TABLE XX

WORKLOAD, PRESENT STAFFING, AND ESTIMATED WORK EFFICIENCY

TANTA LABORATORY - 1978

Bacteriology Section	Number Procedures	Present Staffing	Estimated Work Efficiency*	Combined Efficiency
Blood Cultures	2,863			
Widal & Weil-Felix R.	2,496			
Malta Agglutination	7			
FTA-Abs for Syphilis	32			
VDRL	4,760			
Urine for Parasites	123			
Urine Culture for Salmonella	13,087			
Urine Culture & Sensitivity	95			
Urine for Koch's Bacillus	1			
Stools for Parasites	9			
Stools for Salmonella	13,088			
Stools for Shigella	10,936	26	80	80
Food Bacteriology	2,957			
Stomach Washings	7			
Sputum Bacteriological Exam.	42			
Prostatic Secretion	6			
Sterility Tests for Solutions	53			
Bacteriological Exam. of C.S.F.	254			
Culture for Diphtheria Swabs	21,907			
Exam. of Rats for Plague	311			
Swabs for Vibrios	56,897			
Water for Vibrios	6,734			
Other Bacteriological Tests	175			
Bacteriological Exam. of Water	5,972			
CLINICAL PATHOLOGY				
Hematology & Biochemistry	1,975**	7	4	
CHEMISTRY SECTION (FOOD)	22,606***	21	80	45
WATER SECTION (CHEMICAL ANALYSES OF WATER & WASTES)	774	16	6	
OFFICE OF LABORATORY DIRECTOR		6	N/A	
TOTAL		76		

* Computed in same manner as that for CPHL. See Appendix II for this methodology. Note that in Table XIX only a certain number of professional and technical personnel were used in computing work efficiency. If all personnel had been used in this computation, as is done in the United States, the efficiency percent would have been considerably lower.

** Includes such routine tests as CBC, SR, Prothrombin time, Blood parasites, Fragility RBC, Blood sugar, Blood cholesterol, Bilirubin, Blood urea, Creatinine, Proteins, Chlorides, Enzymes, etc.

*** Tests for milk, cheese, tea, canned goods, etc.

Source: Dr. Elias Dib Aziz

if items available were outdated, in short supply, deteriorating, or in sufficient quantities in case of a substantial periodic workload increase, such as that needed to support an epidemiologist study or disease outbreak. Other than the above, the overall system appeared to be functioning well.

d. Specimen and sample receiving is done on a decentralized basis. This causes a problem in the areas of biological and chemical safety, as well as related security problems since outside personnel can go about the laboratory areas as they please. Furthermore, this makes it more difficult to establish a clear policy as to documentations of items received, as well as conditions of acceptance and storage.

e. Operating cost data could not be obtained except in the area of labor costs. All necessary data was not available in the Tanta laboratory since budgets and expenditures data are kept in the Health Directorate office. Workload and staffing data was available, however, for the U. S. project team to compute an estimate of work efficiency. Both cost and efficiency data is needed by the Tanta Laboratory Director in order to provide accurate data and estimates to justify future laboratory needs.

f. There is no clear organizational delineation as to who is responsible for such scientific and administrative services such as epidemiological coordination, procurement of supplies and equipment, storage and inventory control, equipment maintenance, records and reporting of laboratory results and related data, continuing education and training, personnel training and related records, budget and accounting, custodial and security functions, animal holding, media preparation and other support services. Coordination and delivery of such services within the laboratory are necessary to ensure the support needed on a daily basis by the professional and technical personnel. For example, a problem may arise regarding proper quantities of media, reagents, or chemicals in a particular time period and this could be related to proper procurement practices, proper storage and issue practice, and/or assignments of personnel performing these functions. Another example is the coordination of delivery of significant laboratory results to the Directorate's disease control and epidemiological functions and follow-up to determine what is done with these results and the additional role the laboratory must play if an epidemiological study needs to be made or a disease outbreak occurs.

In the above regard, it is recommended that:

1. Dr. Elias Dib Aziz, with the assistance and approval of Dr. Diab, the Director General of the Gharbia Health Directorate, institute the following changes in the organization and functions of the Tanta laboratory:

a. Establish policies, procedures, and intra-governate communications whereby the Tanta laboratory will:

(1) Become the principal public health laboratory of the province and be known as the Provincial Laboratory - a key entity of the Gharbia Health Directorate as shown in Figure 7.

(2) Be focal point for all laboratory activities in the province. This will involve:

(a) The establishment of the provincial laboratory as a provincial diagnostic reference center. This includes either testing of specimens or functioning as the central collection point for sending reference specimens to the CPHL in Cairo.

(b) The performance of certain public health related diagnostic work of disease control significance not done in other provincial health facilities.

(c) The performance of laboratory work in direct support of epidemiological studies and disease outbreaks.

(d) The technical supervision over provincial health facility laboratories regarding:

1 Standardization of methods, procedures, and equipment as determined originally by CPHL. The provincial laboratory director should provide input to CPHL as to provincial needs.

2 Assistance to CPHL in the inspection and licensure of laboratories.

(e) The evaluation of needs for training of laboratory personnel for all facilities.

(f) The evaluation of service levels for all provincial facilities. This involves the exact determination of which tests should be accomplished in each facility laboratory with the assistance and agreement of the medical staff concerned.

(g) The establishment of a provincial data center for all laboratory and related data (skills and number of persons by skill, number of tests, methodology involved for each test, equipment used, departments and/or disciplines involved, size of laboratory, number of positive results and other data as needed). These data should be forwarded to CPHL on a periodic basis.

(h) The development of cost and efficiency data for each facility laboratory for planning and budgeting purposes.

(i) Participation in basic and applied research activities as applicable.

(j) Technical consultation to provincial facility personnel as requested or when deemed necessary.

(k) Assistance to Directorate program directors in the planning of new or expanded facilities where laboratories are concerned.

b. Establish separate and distinct major provincial laboratory functions for virology and parasitology in support of governate needs regarding reference diagnostic work and disease control and epidemiology initiatives. In virology, necessary virus serology work would be accomplished at the outset, and in the future, testing for polio, hepatitis, rabies, and trachoma should be included. Other virus specimens can be centrally collected and sent to CPHL in Cairo. As needs necessitate, other viral work can be added. In parasitology, the laboratory can serve as the provincial diagnostic reference center for malaria, filaria, schistosomiasis, amoebiasis, and other related parasitic diseases as needs dictate.

c. Add certain testing to the present bacteriology function to include gonorrhea, certain miscellaneous testing not presently done, and provide tuberculosis referrals to CPHL in Cairo.

d. Change the Clinical Pathology function's nomenclature to Pathology, and include a Histopathology function to support reference specimens from provincial facility laboratories. Biochemistry and hematology work for private patients or for testing that can be accomplished in provincial facilities should be discontinued. A nominal amount can be accomplished, however, in support of training where deemed necessary.

e. Combine the present Chemistry and Water Sections (water and waste chemistry) into one Chemistry function.

f. Provide for equipment standardization and on-site maintenance of laboratory equipment and instrumentation. This includes trained personnel, a preventive maintenance system, and spare parts and components to support equipment repair needs. (See discussion regarding this for CPHL - Page 44).

g. Establish a separate organizational entity called Administrative and Scientific Services in order to consolidate all present and proposed administrative and scientific services which are needed to support the Provincial Laboratory Director (Dr. Elias Dib Aziz) as well as the rest of the laboratory's scientific community. These functions would include those of epidemiological coordination (reporting and communication of positive results, periodic reporting to the Directorate's epidemiology function, and coordination of laboratory participation in studies and outbreaks), statistical (see a.(2)(g) and (h) above - Page 61) administrative support for other records, reporting that budgeting and accounting deemed necessary by the Director-General (Dr. Diab), procurement, personnel and training activities, central media preparation, animal holding, stores and inventory control,

maintenance of equipment, and custodial and security. Such a centralization provides for better cross-utilization of personnel as well as placement of responsibility for better and constant support of the scientific community.

h. Set up and implement systems for inventory control, service levels, cost and efficiency and related administrative and scientific support procedures. These are described in the section of this report dealing with the CPHL. (Page 44)

The above proposals are depicted in Figure 9 entitled Proposed Organization and Functions - Provincial Laboratory - Tanta.

2. Facility plans for the provincial laboratory as outlined in a separate section of this report be implemented in consonance with recommendation 1. above.

3. Consideration be given to the proposed staffing plan shown in Table XXI which provides recommended staffing to support the proposed organization and functions shown in Figure 9. Facility plans are also based on proposed organization and staffing changes.

PROVINCIAL FACILITIES AND FACILITY LABORATORIES

The provincial facilities (health units and centers, rural hospitals, general hospitals, etc.) deliver the preponderance of the health care in Egypt's health care delivery system, and every effort is being made by Dr. Diab and his staff to provide optimum care with the minimal resources available. One approach is to provide as much preventive care as possible in the lower level facilities such as health units, centers, and clinics so as to lower the incidence of curative care in higher level facilities such as hospitals. In consonance with this effort, other preventive measures used are health education, environmental protection, which includes safe food and water supplies, waste disposal, insect control, occupational health measures, and certain disease control and epidemiological measures. In essence, the health care provided in the provincial facilities is that care which is "close" to the people - and, in reality, should place a heavier burden on facilities at the lower level in order to prevent the need for more extensive care at higher level facilities. The laboratory plays a major role in the health care system at all levels - but in Egypt, where infectious diseases are of such high prevalence, accurate laboratory results made available as soon as possible at the lowest level facility, assists the medical community in immediate patient treatment, provides disease control and epidemiological data for Directorate program decision making, such as that needed for disease outbreaks, and ultimately prevents morbidity and mortality. The U. S. project team was most impressed with the health care facility strata and was asked to evaluate the laboratory organization at each facility level - especially at the lower levels - and recommend improvements as necessary. Dr. Diab and his staff recognized that much improvement is necessary and this has not been forthcoming due to budget and other constraints, and the growing needs of the ever-expanding population in the province. General problems areas found and discussed during the U. S. project team's visit were:

FIGURE 9
Proposed Organization & Functions — Provincial Laboratory — Tanta

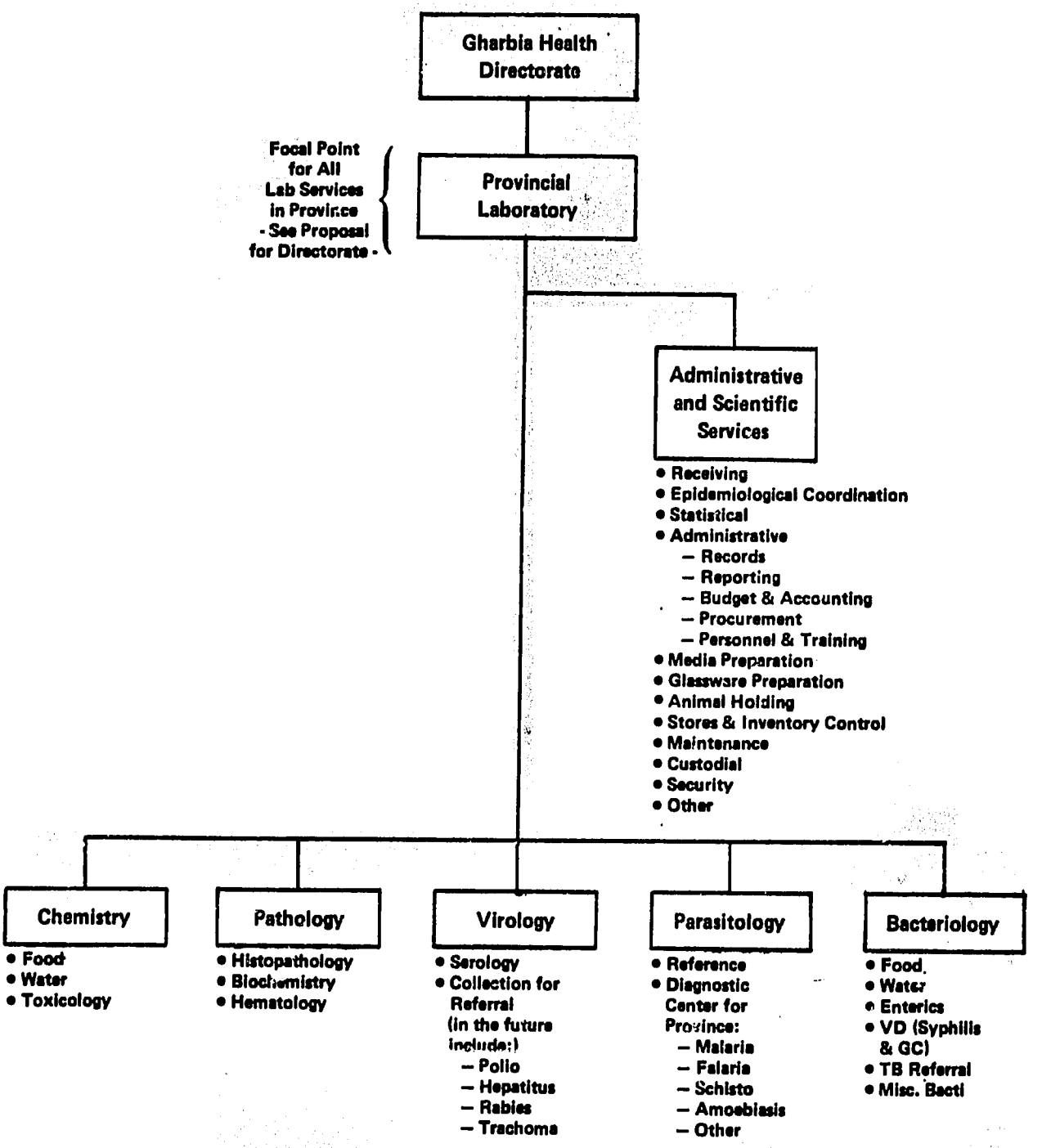


TABLE XXI

PROPOSED STAFFING - PROVINCIAL LABORATORY - TANTA

Proposed Organization	Present Staffing	Proposed Staffing	Remarks
OFFICE OF LABORATORY DIRECTOR	*1 Clinical Pathologist 6 Clerks 7	1 Clinical Path.(Dir.) 1 Clerk 2	
ADMINISTRATIVE & SCIENTIFIC SERVICES		1 Supervisor	
Receiving		2 Clerks + 2 laborers	Clerical and laborer positions transferred from other organizations. Some positions substituted as a result of estimated needs. It should be noted that clerks and laborers positions can be cross-utilized as needs dictate so as to receive full utilization of all personnel.
Epidemiological Coordination		7 Clerks	
Statistical		7 Clerks	
Administrative		7 Clerks	
Media Preparation		2 Technicians + 1 laborer	
Glassware and Related Prep.		4 Laborers	
Animal Holding		1 Laborer	
Stores & Inventory Control		2 Clerks + 1 laborer	
Maintenance		2 Maintenance repairmen + 1 laborer	
Custodial Security		1 Clerk + 5 laborers	
		32	
CHEMISTRY (Combines Chemistry & Water Sections of Present organization.)	20 Chemists 1 Technician 5 Clerks 11 Laborers 37	1 Supervisory Chemist 13 Chemists 1 Technician 15	Number of Chemists reduced due to efficiency. Chemists can be substituted in other areas until attrition corrects staffing.
PATHOLOGY	*1 Clinical Pathologist (dual capacity) 1 Chemist 2 Technicians 3 Laborers 6	1 Clinical Pathologist 2 Chemists 3 Technicians 6	1 Clinical Pathologist position added. Director can serve as Consultant to this function as necessary.
VIROLOGY	-	1 Working Supervisory Virologist 1 Virologist 2 Technicians 2 Lab. Assistants 6	Added positions.
PARASITOLOGY	-	1 Working Supervisory Bacteriologist 2 Technicians 1 Lab. Assistant 4	Added positions.
BACTERIOLOGY	2 Bacteriologists 2 Doctors in Training 5 Technicians 3 Lab. Assistants 3 Clerks 11 Laborers 26	1 Working Supervisory Bacteriologist 1 Bacteriologist 2 Doctors in Training 4 Technicians 3 Lab. Assistants 11	
TOTAL	76	76	

*Dual capacity.

1. Rural Health Units and Centers:

a. The "Palquist card" methodology used for testing hemoglobin is considered obsolete.

b. Microscopes used, although usually working properly, were of a wide variety of models. In turn, natural light was used in lieu of a light source, thus making it more difficult for use.

c. Hand centrifuges were used in most facilities observed, thus making procedural steps using centrifuges less accurate and more time consuming.

d. Supplies, such as dyes, stains, chemicals, and related supplies were usually in short supply or there were instances where supplies were occasionally not available.

e. Laboratory personnel were of "mixed" training experience - mostly "on the job." Checks of personnel proficiency were not being done.

f. None of the personnel contacted knew of or used the minimum diagnostic reference services available in the Tanta Public Health Laboratory.

2. District and General Hospitals:

a. Equipment and instrumentation used was of a wide variety of models and from many different countries. Maintenance of this equipment is difficult and spare parts are either difficult to obtain or are not available. Some equipment is very old or obsolete and could not be used to the extent needed.

b. Expendable supplies, such as reagents and chemicals, were occasionally short or not available. A system for determining periodic needs and reorder points was not used and individual laboratory personnel appeared to be responsible for having proper quantities on hand.

c. There was no compendium of laboratory services available for the medical staff to use in ordering patient testing.

d. Based on interviews and observation, laboratory services available are not comprehensive enough to adequately support the medical staff. This includes a lack of pathology services, proper blood chemistry procedures, proper microbiology procedures (as an example, in El Santa District Hospital with many physicians of specialized training and treating patients with complex medical problems, no blood chemistry procedures were offered and needed microbiology procedures were not available), and proper blood banking services.

3. Specialty Units and Hospitals:

a. The "Palquist card" methodology used for testing hemoglobin is considered obsolete and the hematocrit test was not available.

b. Laboratory services, for the most part, were not comprehensive enough to handle all the problems observed. This includes testing for microbiology (culture ability for blood, stools, and sputum) in the fever and chest hospitals. Also, the Tanta fever hospital did not offer blood chemistry services to the medical staff. (The above problems were also evident in the Imbaba Fever Hospital in Cairo.)

c. The problems involving equipment and instrumentation maintenance observed in the district and general hospitals were also found. This includes the Imbaba Fever Hospital in Cairo.

d. Supply shortages were noted by the staff interviewed.

e. As previously mentioned, the U. S. project team observed that much of the health care delivered in the specialty facilities - including the laboratory services - could be done in the rural, district, and general hospitals as well as done in outpatient facilities in the health centers and units. An overall advantage, then, would be the closing of obsolete facilities and making scarce resources available to improve the primary health care facilities - hospitals, health centers and health units.

In the above regard, it is recommended that:

1. Dr. Diab and his staff (as recommended in a previous section of this report) assess, as previously recommended, the need for certain specialty facilities in the province - especially infectious disease, fever, and chest hospitals, with the objective to combine or close unnecessary facilities.

2. Dr. Diab give authority and resources to Dr. Elias Dib Aziz to determine and establish proper service levels (which tests should be done in each facility) on an ongoing basis, establish equipment and instrumentation requirements in each facility, determine and establish personnel needs and skills requirements for each facility, and supply needs for each facility.

3. Testing methodology be standardized as practicable throughout the Province to provide for more efficient training of personnel, standardized reporting, better personnel proficiency and the ability to periodically measure this proficiency, standardization of controls and standards, equipment and instrumentation and laboratory supplies. Dr. Diab should provide Dr. Elias Dib Aziz with the authority to make such changes.

4. Service levels determined by Dr. Elias Dib Aziz and sent through organizational channels to Dr. El Gamal and to the U. S. project team be instituted as practicable. These service levels are shown in the United States project officers' preliminary report, but are not complete. The service levels for health centers and health units should be implemented

immediately - especially that concerned with hemoglobin testing using a more modern technique. In addition, standard items of equipment such as hemoglobinometers, microscopes with light sources, electric driven centrifuges, and other related equipment should be placed in the health centers and health units, as well as other facilities as needed.

5. Equipment and instrumentation standardization practices begin as soon as practicable throughout the province. This has been discussed in some detail in previous sections of this report.

6. Preventive maintenance requirements for facility equipment and instrumentation be established by Dr. Aziz and his recommended maintenance staff. Maintenance work in the facilities would also be done by this staff unless certain facilities provide their own personnel to do this or equipment is under company warranties.

7. That management techniques for storage and inventory control be instituted as practicable.

FACILITIES PLANNING

Several laboratory facilities at various levels of health care in Cairo and the Gharbia Province were inspected; however, this portion of the report will direct emphasis primarily to the Central Public Health Laboratories (CPHL) and the Tanta (Gharbia Provincial) Laboratory.

CPHL - Existing Conditions

These laboratories are located in a building containing three floors, a basement, and a partial floor at the main roof level. There are also differences in floor levels between the original front building wing and the main building. It is not known exactly when the building was constructed, but estimates suggest that it may be as much as 100 years old, with the original front wing being even older. Due to the age of the building, original plans are not available. The plans furnished are the result of actual measurements and do not show the details of construction that are normally shown on original plans. There are discrepancies in the scale dimensions on the plans that are available. For this reason, any existing conditions which may affect any recommendations in this report should be verified.

The CPHL facility is in very poor condition. The following are the more significant inadequacies:

1. Poor utilization of space and fragmentation of some laboratory functions.
2. Lack of air-handling equipment to provide biological and chemical safety.
3. Lack of adequate plumbing and electrical systems.
4. General deterioration of windows, floors, ceilings, doors, benches, etc.
5. Water leakage at roof and basement walls and floors.
6. Lack of adequate housekeeping.

Most walls in the building are load-bearing and cannot be removed. Although the building needs substantial renovation, it appears to be structurally sound.

CPHL - Recommendations

The facility requirements and recommendations contained herein are based on factors such as the proposed organizational structure, workload, staffing, equipment, biological and chemical containment requirements, etc.

The following is a tabulation of proposed net space requirements to support the proposed organization and functions shown on Figure 5 (Page 43):

					Sq. Mts.
I.	OFFICE OF DIRECTOR GENERAL				70
	A. Director's Office			25	
	B. Secretary, Clerical			45	
II.	DIRECTOR OF ADMIN. & SCIENTIFIC SERVICES				1,465
	A. Director's Office			20	
	B. Clerical			30	
	C. Administrative Services			480	
	1. Supv. Office		15		
	2. Clerical, Files		180		
	3. Personnel		60		
	4. Budget & Accounting		60		
	5. Procurement		50		
	6. Lounge, Cafeteria		100		
	7. Mail Room		15		
	D. Scientific Services			590	
	1. Supv. Office		15		
	2. Clerical, Files		10		
	3. Central Specimen Receiving		60		
	4. Container Prep.		25		
	5. Storage & Inventory Control		220		
	a. Inventory Control, Files	15			
	b. Expendable Supplies	40			
	c. Gen. Lab. Supplies	100			
	d. Lab. Equipment Holding	20			
	e. Volatile Storage	25			
	f. Shipping & Rec.	20			
	6. Glassware Preparation		190		
	a. Decontamination	15			
	b. Sorting, Washing, Drying	60			
	c. Inspection, Wrapping	30			
	d. Sterilization	30			
	e. Clean Glass Storage	55			
	7. Animal Quarters-Holding		70		
	a. Clean Animal Room	10			
	b. 2-Experimental Animal Rooms	25			
	c. Cage Washing	10			
	d. Cage & Feed Storage	10			
	e. Incinerator	5			
	f. Bedding & Supplies	10			

				- - - - - - Sq. Mts. - - - -	
II.	DIRECTOR OF ADMIN. & SCIENTIFIC SERVICES (Cont.)				
	E. Engineering Services			19(	
	1. Supv. Office		15		
	2. Engineering, Drafting, Clerical		60		
	3. Shops		115		
	a. Carpentry	30			
	b. Plumbing	20			
	c. Auto	40			
	d. Electrical	15			
	e. Paint	10			
	* 4. Parking		--		
	a. 10 Official Veh.	--			
	b. 30 Private Veh.	--			
	F. Training & Continuing Educ. Coord.			155	
	1. Supv. Office		15		
	2. Clerical, Records		20		
	3. Training Laboratory		60		
	4. Training Equip. & Supplies		10		
	5. Library, Lecture, Conf.		50		
III.	LICENSURE				60
	A. Supervisor's Office			1!	
	B. Clerical, Files			15	
	C. Inspector's Office			30	
IV.	EPIDEMIOLOGY				25
	A. Liaison Office			1!	
	B. Clerical, Files			1(	
V.	LABORATORIES (Departments)				1,640
	A. Chemistry			455	
	1. Dept. Director's Office		15		
	2. Clerical, Files		30		
	3. Water Section		110		
	a. Laboratory	100			
	b. Storage	10			
	4. Food Section		300		
	** a. Laboratory	280			
	b. Storage	20			

*Area not included.

**Includes the following:

- Tea & Coffee
- Coloring
- Canned Food
- Spices
- Milk & Cheese
- Fats & Oils
- Flour & Cereal

- - - - - - Sq. Mts. - - - - -

V. LABORATORIES (Departments) (Cont.)

B. Pathology			235
1. Dept. Director's Office		15	
2. Clerical, Files		30	
3. Histology Section		110	
a. Laboratory	70		
b. Slide Storage	30		
c. FA Room	10		
4. Biochemistry Section		40	
a. Laboratory	30		
b. Storage	10		
5. Hematology Section		40	
a. Laboratory	30		
b. Storage	10		
C. Virology			165
1. Dept. Director's Office		15	
2. Clerical, Files		40	
3. General Lab.		40	
4. Isolation Room		10	
5. Rabies Lab.		10	
6. Head Opening Room		10	
7. Sterile Room		10	
8. Egg Room		10	
9. T. C. Room		10	
10. FA Room		10	
D. Parasitology			85
1. Dept. Director's Office		15	
2. Clerical, Files		20	
3. Laboratory		40	
4. FA Room		10	
E. General Bacteriology			660
1. Dept. Director's Office		15	
2. Clerical, Files		50	
3. Water & Food Lab.		110	
4. Enterics Lab.		30	
5. VD Lab.		80	
6. Mycobacteriology		50	
a. Gen. Lab.	40		
b. Isolation Room	10		
7. Misc. Pathogens Lab. (Adj. TB)		120	
8. Bact. FA Room		20	
9. Media Preparation		155	
a. Ingredient Storage	15		
b. Mixing & Cooking	40		
c. Tube Dispensing	30		
d. Aseptic Transfer	20		
e. Sterilization	30		
f. Quality Control	10		
g. Pick-up Area	10		
10. Reagent Prep.		30	
F. Research Lab.			40
Total Net Space Requirement			3,260 Sq.Mts.

These areas represent the ideal net floor space required for the various program activities projected 5 to 10 years, and are appropriate for a new laboratory building; however, since the laboratory operation will remain in the existing building, the spaces shown are only used as a guide. Since some of the spaces listed above may not exactly fit in available rooms, some laboratory functions are split between two or more rooms. This condition would not exist in a new laboratory facility since the spaces could be made larger or smaller. Functions are, therefore, located in such a way as to gain maximum utilization of the existing building and the proposed extensions.

Figures 10, 11, 12, 13, and 14 show the proposed layout for CPHL in its present building. This layout is contingent on the following:

1. Relocating the present Ministry of Health Library and Offices of the Undersecretary to other facilities.

2. Expanding the partial floor at the roof level to include most of the existing roof area as indicated.

3. Expanding the first and second floors.

4. Utilizing the rooms at the basement level not presently used.

5. Reworking the southeast area of the building near the court.

The layouts included in this report show only the proposed conditions or changes and do not show the total arrangements as they presently exist. Information on the approximate present arrangement may be obtained by referring to the layouts which were furnished for this study.

Since the layouts furnished do not accurately represent all existing conditions and due to reproduction distortions, the scale indicated is only approximate.

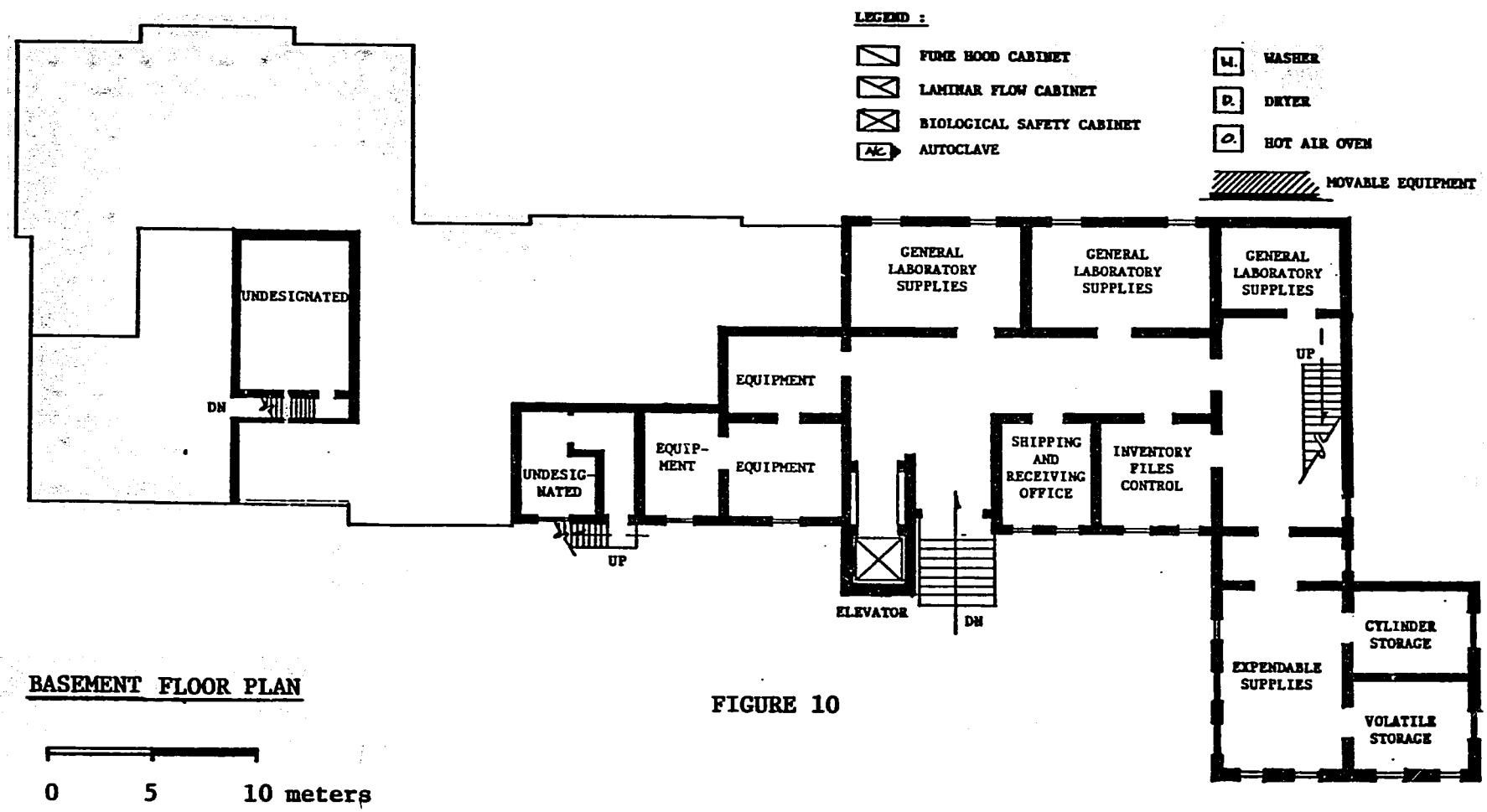
The following are CPHL facility recommendations:

1. Remove antiquated laboratory benches and install new benches similar to those presently installed in the recently renovated laboratory areas. The benches should follow the general configuration as indicated on the layouts in this report. Install new stainless steel sinks as new benches are installed.

2. Repair walls and floor structure as required, and install new floor finishes as described. Remove deteriorated wood flooring and replace with wood or concrete fill which will receive new seamless floor finish. Carpet is recommended for the Director General's Office and the Library/Conference Room. Seamless floor finishes are recommended for all other rooms and corridors. Floors and steps at entrance and in lobbies on each floor should remain a masonry tile finish, but repaired or replaced where damaged or in areas of excessive wear.

4. Construct new roof additions as indicated on the proposed layout. These additions should be provided with adequate services to meet

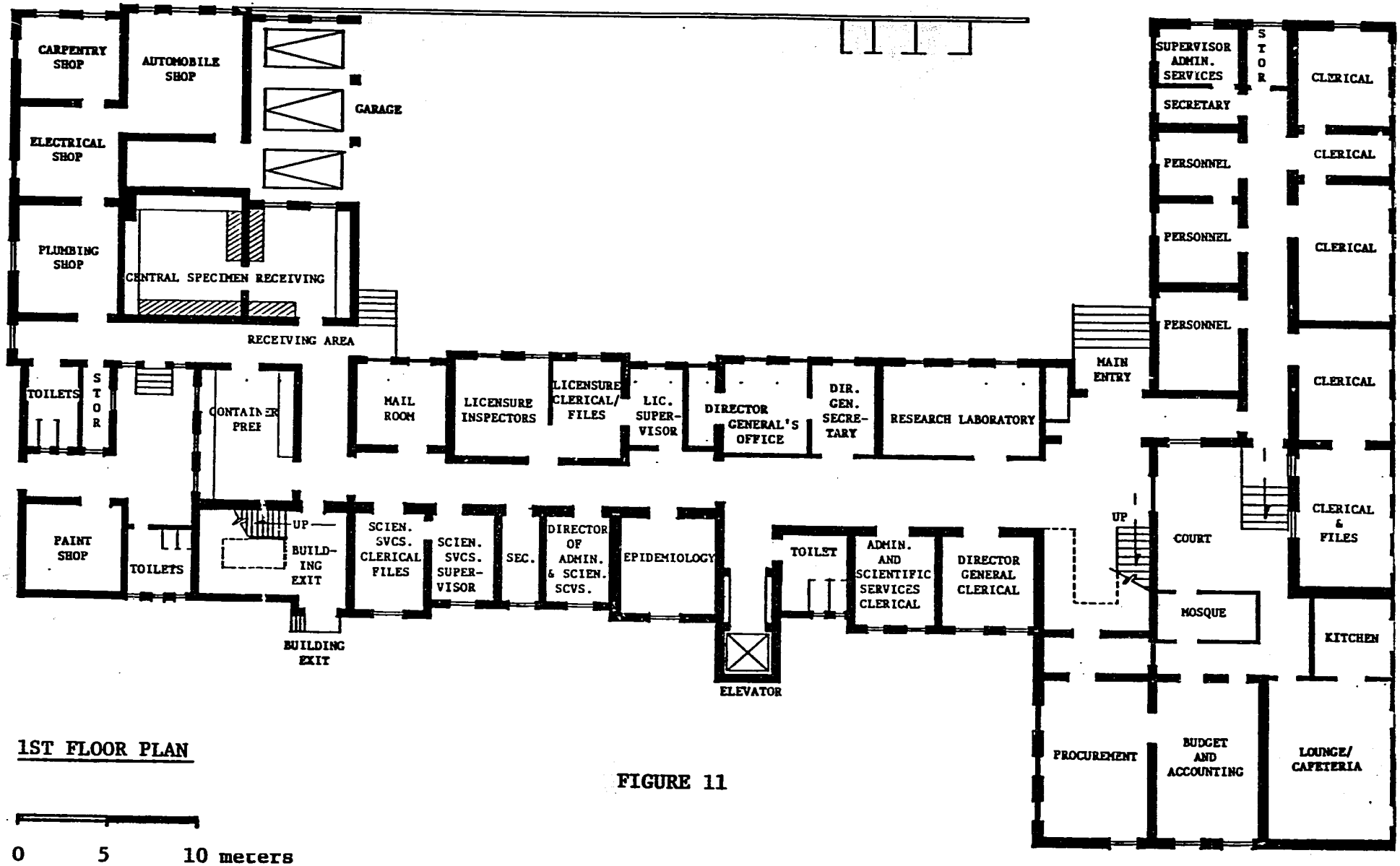
CENTRAL PUBLIC HEALTH LABORATORIES
MINISTRY OF HEALTH
CAIRO, EGYPT



BASEMENT FLOOR PLAN

FIGURE 10

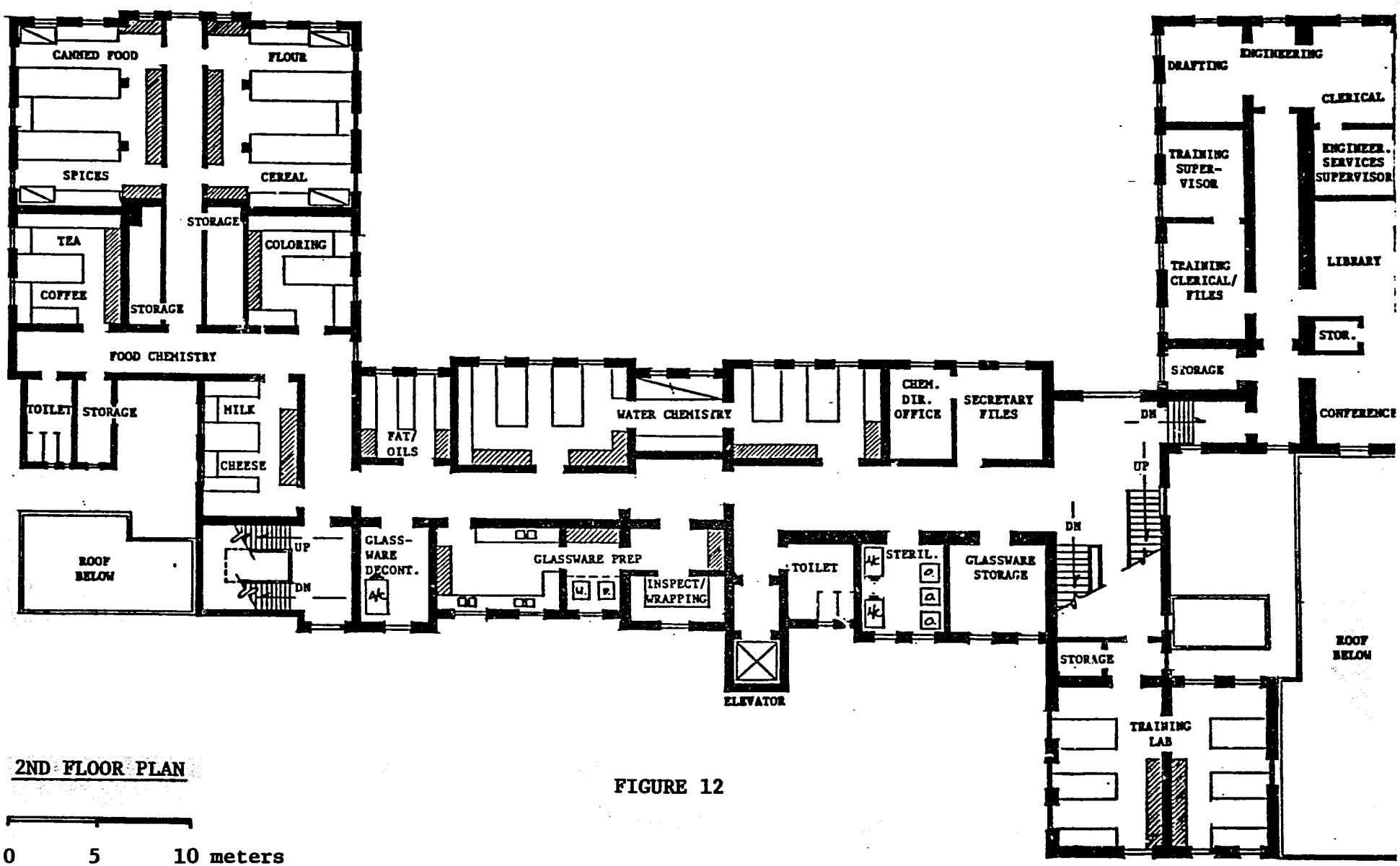
CENTRAL PUBLIC HEALTH LABORATORIES
MINISTRY OF HEALTH
CAIRO, EGYPT



1ST FLOOR PLAN

FIGURE 11

CENTRAL PUBLIC HEALTH LABORATORIES
MINISTRY OF HEALTH
CAIRO, EGYPT

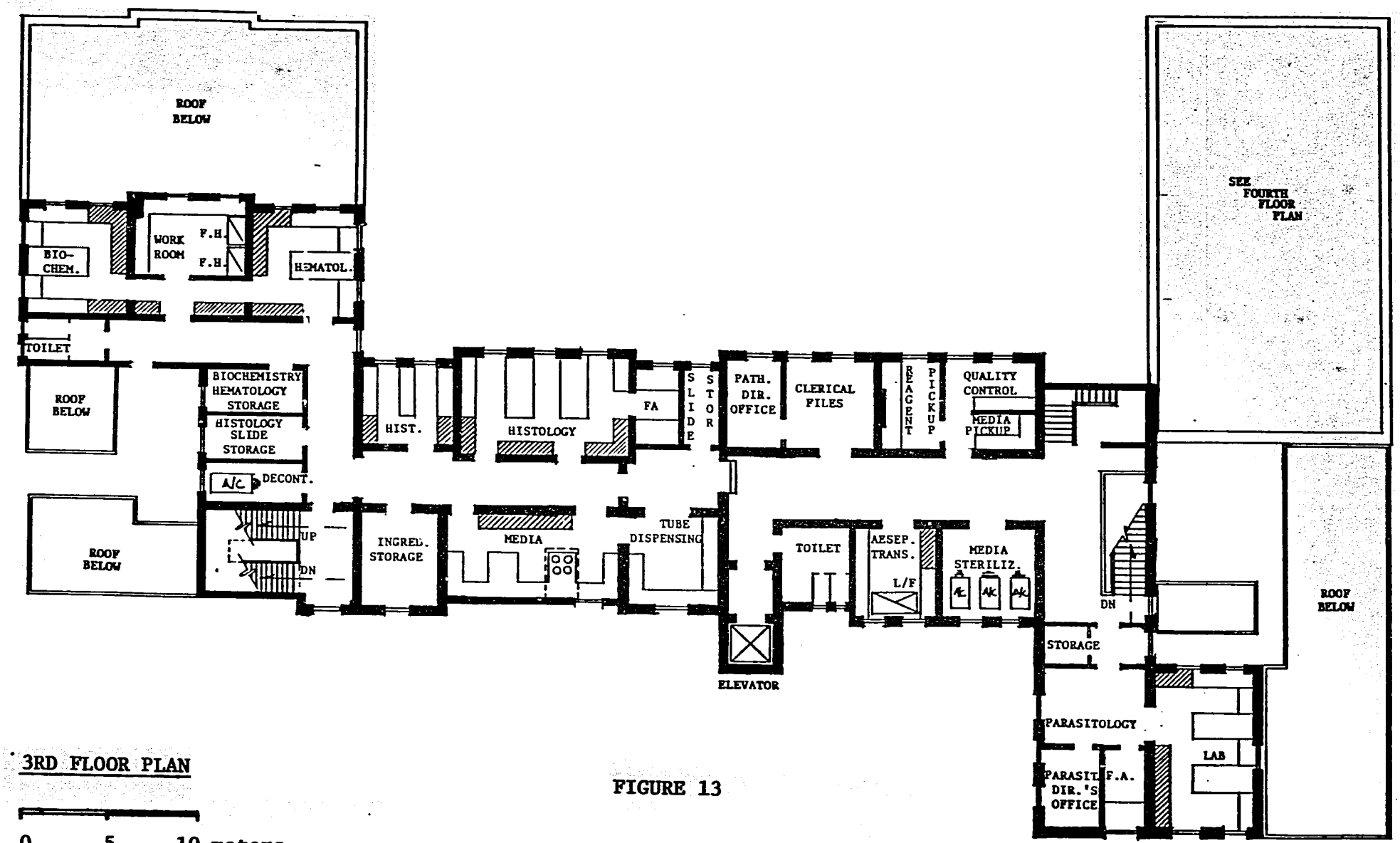


2ND FLOOR PLAN

0 5 10 meters

FIGURE 12

CENTRAL PUBLIC HEALTH LABORATORIES
MINISTRY OF HEALTH
CAIRO, EGYPT

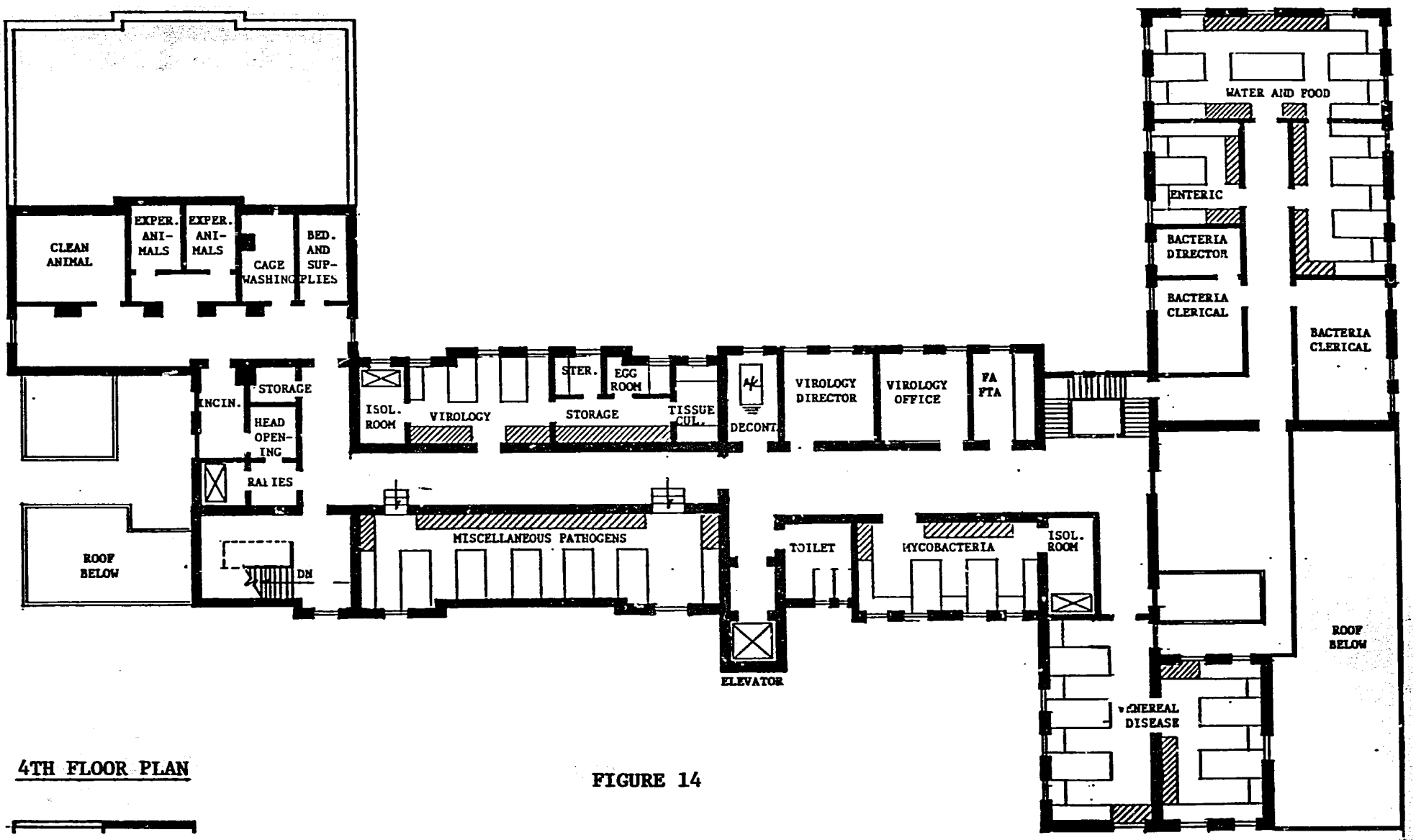


3RD FLOOR PLAN

0 5 10 meters

FIGURE 13

CENTRAL PUBLIC HEALTH LABORATORIES
MINISTRY OF HEALTH
CAIRO, EGYPT



4TH FLOOR PLAN

FIGURE 14

0 5 10 meters

operational requirements. Although the existing roof appears to be sound, a structural engineer should investigate the existing structure and verify that it is adequate to support an additional floor.

5. Install an elevator at the rear of the building to serve all floors.

6. Install suspended acoustical ceilings in the following areas:

   a. Corridors, except in animal and basement areas.

   b. Director General's Office and adjacent secretary/clerical area.

   c. Lounge/Cafeteria.

   d. Library/Conference.

   Repair all other existing ceilings as required. Ceilings in second and fourth floor extensions should be plaster. No ceiling finishes are required at the first floor shop and garage extensions.

7. Replace windows throughout the building, except for those replaced in a recent renovation. Windows should be similar in design to those recently replaced.

8. Provide complete interior and exterior painting/refinishing of all building surfaces except surfaces not intended to be painted or refinished, such as acoustical ceilings, bench tops, architectural stone, masonry floor tile, etc.

9. Remove existing incandescent lighting and install new fluorescent lighting fixtures as required. The lighting levels in administrative and laboratory spaces should be approximately 750 lumens/square meter. Three-hundred lumens/square meter is adequate in corridors.

10. Upgrade the entire electrical system, extending the system into the extensions. Provide electrical receptacles every meter to 1.5 meters along the walls and benches.

11. Install an air-handling system for the entire building. This system should be designed to provide various air pressure relationships in critical areas, as well as adequate heating and cooling. Sufficient volumes of air must be provided to allow proper operation of cabinets and hoods. Air supplied to spaces such as the general virology laboratory, rabies laboratory, rabies head opening room, mycobacteriology general laboratory, and all isolation rooms should not be recirculated to other parts of the building. Approximately 80% recirculation of air is permitted in other spaces.

12. Provide new forced-draft fume hoods and biological safety cabinets where indicated on proposed layouts. These hoods and cabinets must be exhausted individually to the outside to a point above the roof and as far away from windows as possible.

13. Replace drains and install new drains as required throughout the building.

14. A schedule of maintenance should be established for the interior and exterior of the building. The building custodial personnel should accomplish certain general maintenance at various time intervals. Some suggestions are as follows:

Daily maintenance should include:

a. General cleaning of floors. This includes the removal of loose dirt and items accidentally discarded or dropped on the floors.

b. Cleaning of toilet rooms and fixtures.

c. Emptying trash cans and baskets.

Weekly maintenance should include:

a. Thoroughly clean all floor surfaces. This includes complete vacuuming, mopping, and waxing, as needed.

b. Cleaning and polishing of bookcases, tables, chairs, desks, etc.

c. Complete removal of trash from premises.

d. Cleaning and polishing of all interior woodwork.

e. Replacing defective light bulbs and fluorescent tubes

Monthly maintenance should include:

a. Cleaning of all windows on interior and exterior.

b. Providing necessary maintenance within interior courts and on grounds outside the building.

The maintenance schedule should be reviewed from time to time and changes made to satisfy specific requirements.

The custodial personnel should not be expected to clean the bench tops. The respective laboratory staff should assume this responsibility.

15. A preventive maintenance program should be implemented for major items of laboratory and building equipment. With preventive maintenance, problems can be detected and corrected while still minor and before they have the opportunity to cause extensive damage or result in the failure of the equipment. Other problems can be avoided entirely.

While no preventive maintenance program can entirely eliminate all equipment breakdowns, a well-managed program can reduce them to a minimum.

16. Phasing of construction must be included in the overall planning. Renovation is always inconvenient to the occupants of a building; however, every effort should be made to phase the work in a way that allows minimum interruption to the laboratory operation. An approach would be; first, build the expansion space; second, move the Ministry of Health Library and offices of the Undersecretary out of the building and renovate the spaces; and, third, temporarily relocate functions in these areas until the spaces in the existing building are renovated. All areas undergoing renovation and construction should be separated from occupied areas by dust shields.

CPHL - Preliminary Cost Estimate

The following funding breakdown is based on an estimation of current construction cost in Cairo and the assumption that all work will be accomplished by private construction contractors.

Estimates are computed in Egyptian pounds.

Renovation

Construction Cost (5,125 sq. mts. x L.E. 230)	1,178,750
Design & Construction Supervision (10% of Construction Cost)	117,875
Contingencies (5% of Construction Cost)	58,938
Total Renovation L.E.	1,355,563

New Extensions & Elevator

Construction Cost (1,635 sq. mts. x L.E. 350 + Elevator L.E. 85,000)	657,250
Design & Construction Supervision (10% of Construction Cost)	65,725
Contingencies (5% of Construction Cost)	32,862
Total New Extensions L.E.	755,837
Total CPHL Renovation & Extension Funding L.E.	2,111,400 (or $3.02 Million)

The total funding estimate should be increased 8 to 10 percent for every year the work is not accomplished.

It should be recognized that it is very difficult to estimate the cost of renovation since the cost of required demolition is unpredictable. This is especially true in a building where no original construction plans and specifications exist. In many cases, the existing conditions are not often discovered until some demolition has taken place. Due to uncertain conditions and demolition costs, upgrading such a building to first class condition could cost 50 to 100 percent of the cost of new construction.

Tanta (Gharbia Provincial) Laboratory - Existing Conditions

Except for the Water Analysis Laboratory, this laboratory is located in a building containing three floors. The Water Analysis Laboratory is located in an adjacent annex to the Cancer Hospital. The Annex is approximately 7 meters from the laboratory building. As with CPHL, there are no original plans available. The plans furnished were prepared using actual measurements.

The laboratory building appears to be in sound structural condition; however, the laboratory operation is crowded and in need of additional space. Most walls are load-bearing and cannot be removed.

Tanta (Gharbia Provincial) Laboratory - Recommendations

The facility requirements and recommendations contained herein are based on proposed organization, workload, staffing, equipment, biological and chemical containment requirements, etc.

The following is a tabulation of proposed net space requirements to support the proposed organization and function shown in Figure 9 (Page 64):

		- - - - Sq. Mts. - - - -		
I.	OFFICE OF LABORATORY DIRECTOR			40
	A. Director's Office		15	
	B. Clerical, Files		25	
II.	ADMINISTRATIVE AND SCIENTIFIC SERVICES			230
	A. Supervisor's Office		10	
	B. Clerical and Files for:			
	1. Administrative 2. Statistical 3. Epidemiology	50		
	C. Receiving Area for:			
	1. Specimens 2. Supplies	20		

		- - - - Sq. Mts. - - - -		
II.	ADMINISTRATIVE AND SCIENTIFIC SERVICES (Cont.)			
	D. Storage		40	
	1. Lab Supplies	35		
	2. Chemicals	5		
	E. Maintenance		10	
	F. Glassware Preparation		30	
	1. Decontamination, Washing, Drying	15		
	2. Sterilization	15		
	G. Media Preparation		25	
	1. Gen. Prep. & Tube Dispensing	15		
	2. Plate Dispensing	10		
	H. Animal Holding		15	
	1. Clean Animal Room	5		
	2. Experimental Animal Room	5		
	3. Cage, Feed & Bedding	5		
	I. Employee Break Room		15	
	J. Lecture/Conference		15	
III.	LABORATORIES			340
	A. Chemistry		100	
	B. Pathology		40	
	C. Virology		70	
	1. Gen. Laboratory	30		
	2. Rabies Laboratory	10		
	3. Isolation Room	10		
	4. Tissue Culture	10		
	5. FA Room	10		
	D. Parasitology		30	
	E. Bacteriology		100	
	1. Gen. Laboratory	80		
	2. Isolation Room	10		
	3. FA Room	10		
	Total Net Space Requirement			610

These areas represent the ideal net space required for the program activities projected 5 to 10 years, and are appropriate for a new laboratory building; however, since the laboratory operation will remain in the existing building and expand into a proposed extension, the spaces shown are only used as a guide for reallocation of the total space.

Figures 15 through 18 show the proposed layout for the Gharbia Provincial Laboratory. These layouts include the proposed building expansion. Information on the existing layout may be obtained by referring to plans furnished for this study.

The following are Gharbia Provincial Laboratory facility recommendations:

1. Build new extension and alter existing building as necessary to accommodate the extension.

2. Provide complete interior and exterior painting/refinishing of all building surfaces except those not intended to be painted or refinished, such as masonry floors, architectural stone, etc.

3. Upgrade lighting and electrical system in existing structure and provide adequate systems in new extension to attain 750 lumens/square meter in working areas.

4. Provide air-handling system, hoods, and biological safety cabinets similar to those mentioned in CPHL recommendations Nos. 11 and 12.

5. Replace antiquated, damaged and deteriorated laboratory benches with new benches. Existing benches in good condition should be utilized.

6. Implement a preventive maintenance program for major items of laboratory and building equipment. With preventive maintenance, problems can be detected and corrected while still minor and before they have the opportunity to cause extensive damage or result in the failure of the equipment. Other problems can be avoided entirely.

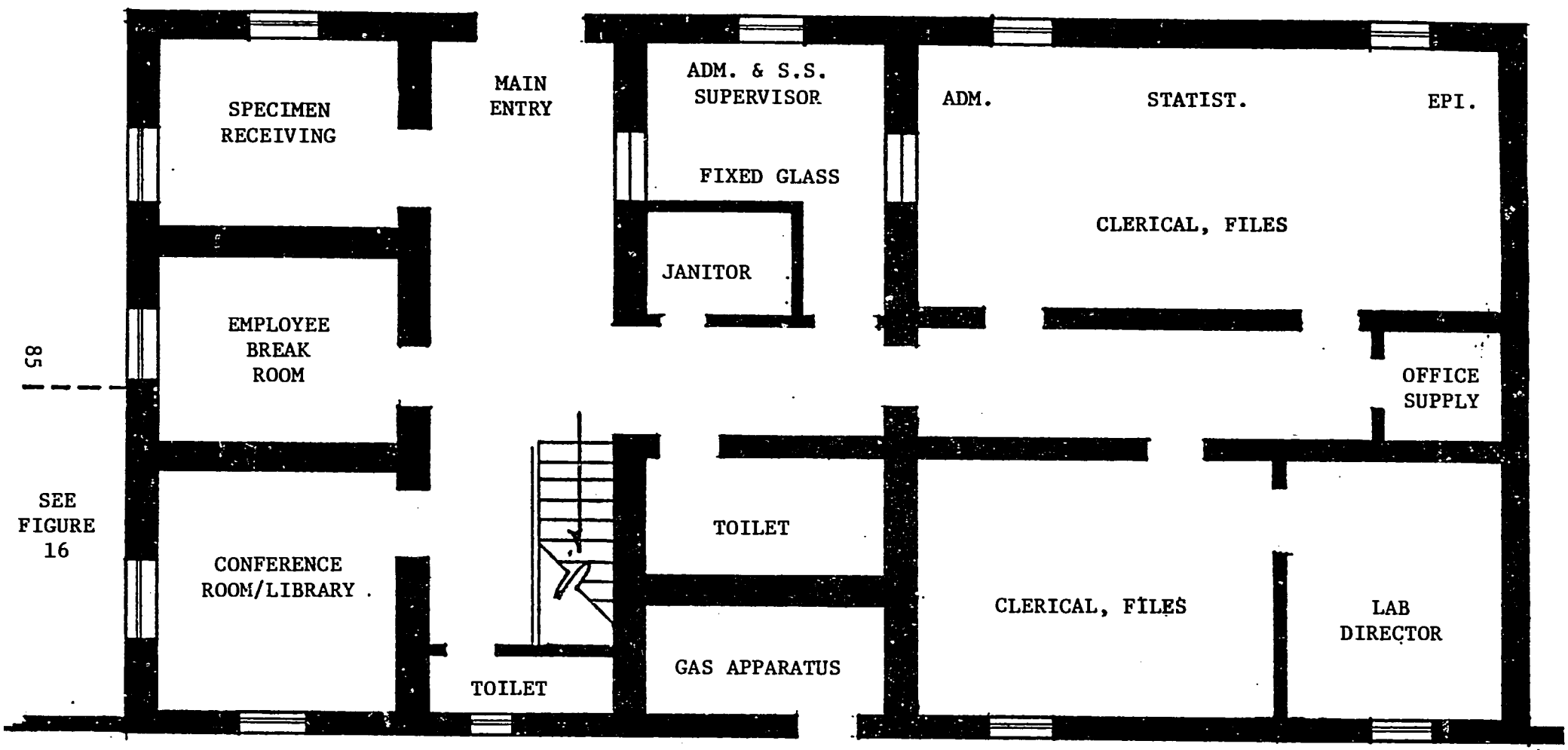
While no preventive maintenance programs can entirely eliminate all equipment breakdowns, a well-managed program can reduce them to a minimum.

7. Provide for phased construction in overall construction planning. Renovation is always inconvenient to the occupants of a building; however, every effort should be made to phase the work in a way that allows minimum interruption to the laboratory operation. An approach would be to build the expansion space and temporarily relocate functions in this space until the existing building is completely renovated. After all renovation is complete, functions should be moved to their permanent location.

GHARBIA PROVINCIAL LABORATORY

MINISTRY OF HEALTH

TANTA. EGYPT



GROUND FLOOR PLAN

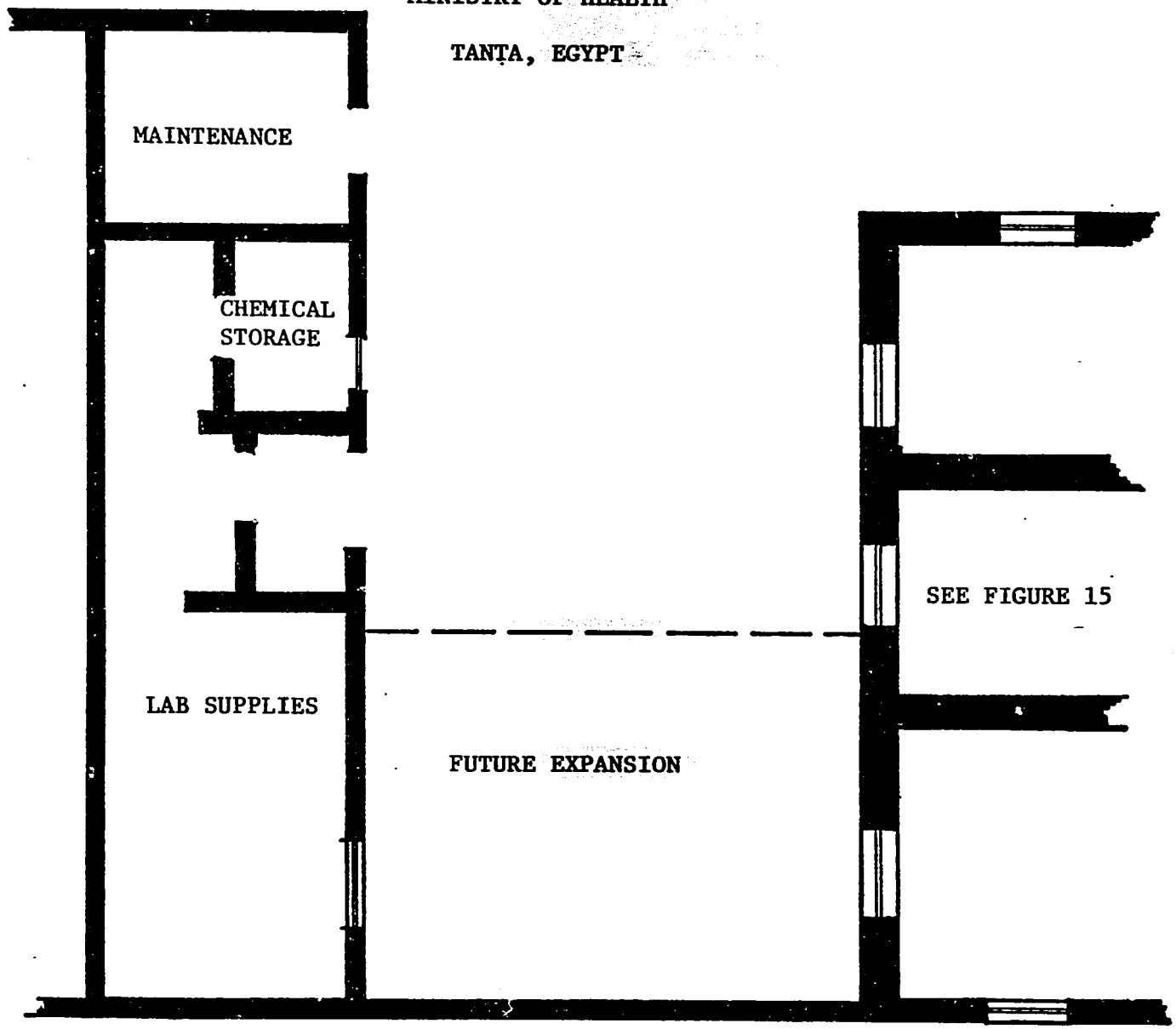
0 1 2 3 meters

FIGURE 15

GHARBIA PROVINCIAL LABORATORY

MINISTRY OF HEALTH

TANTA, EGYPT



GROUND FLOOR PLAN - ANNEX

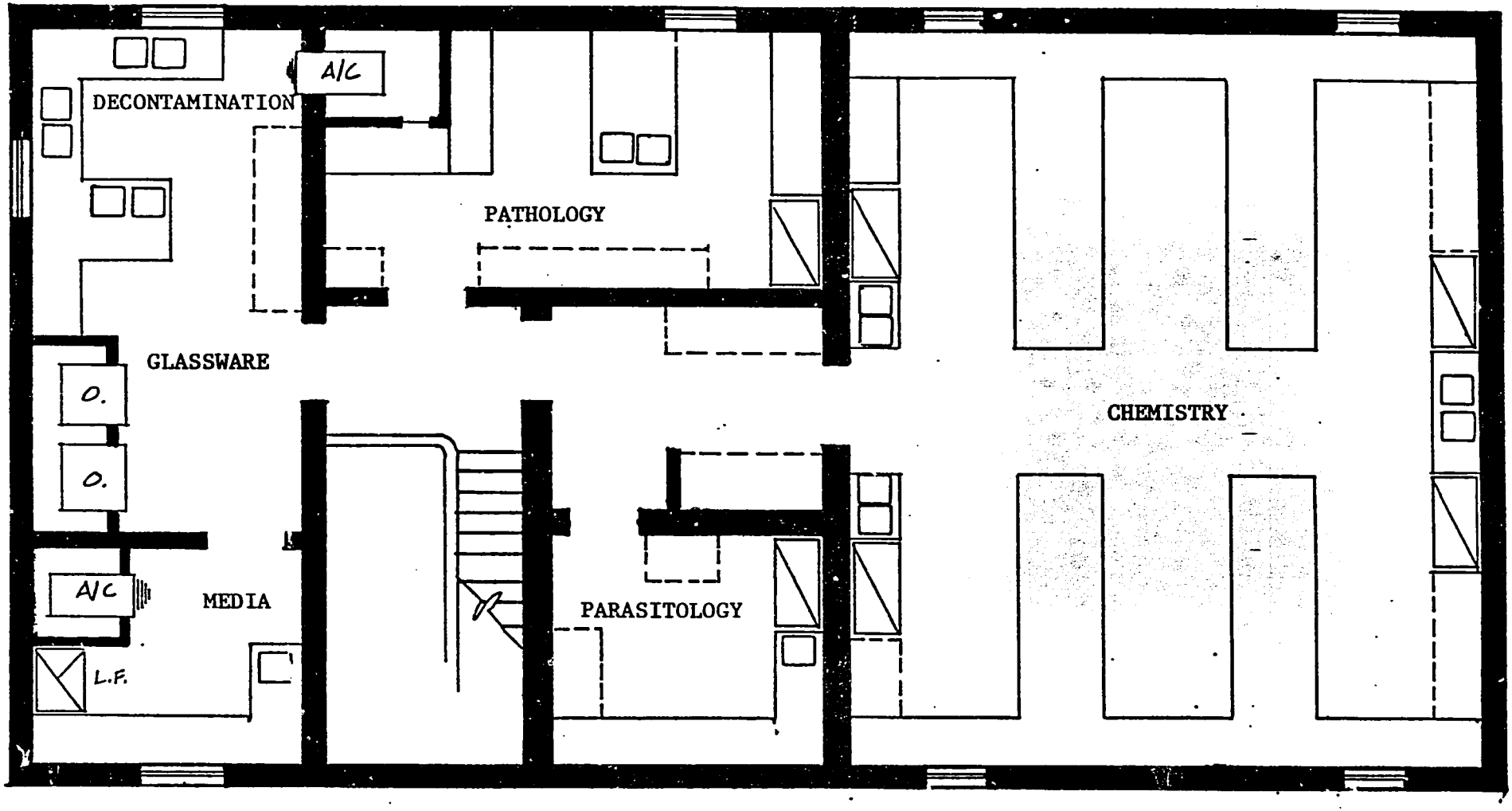
FIGURE 16

0 1 2 3

GHARBIA PROVINCIAL LABORATORY

MINISTRY OF HEALTH

TANTA, EGYPT



FIRST FLOOR PLAN

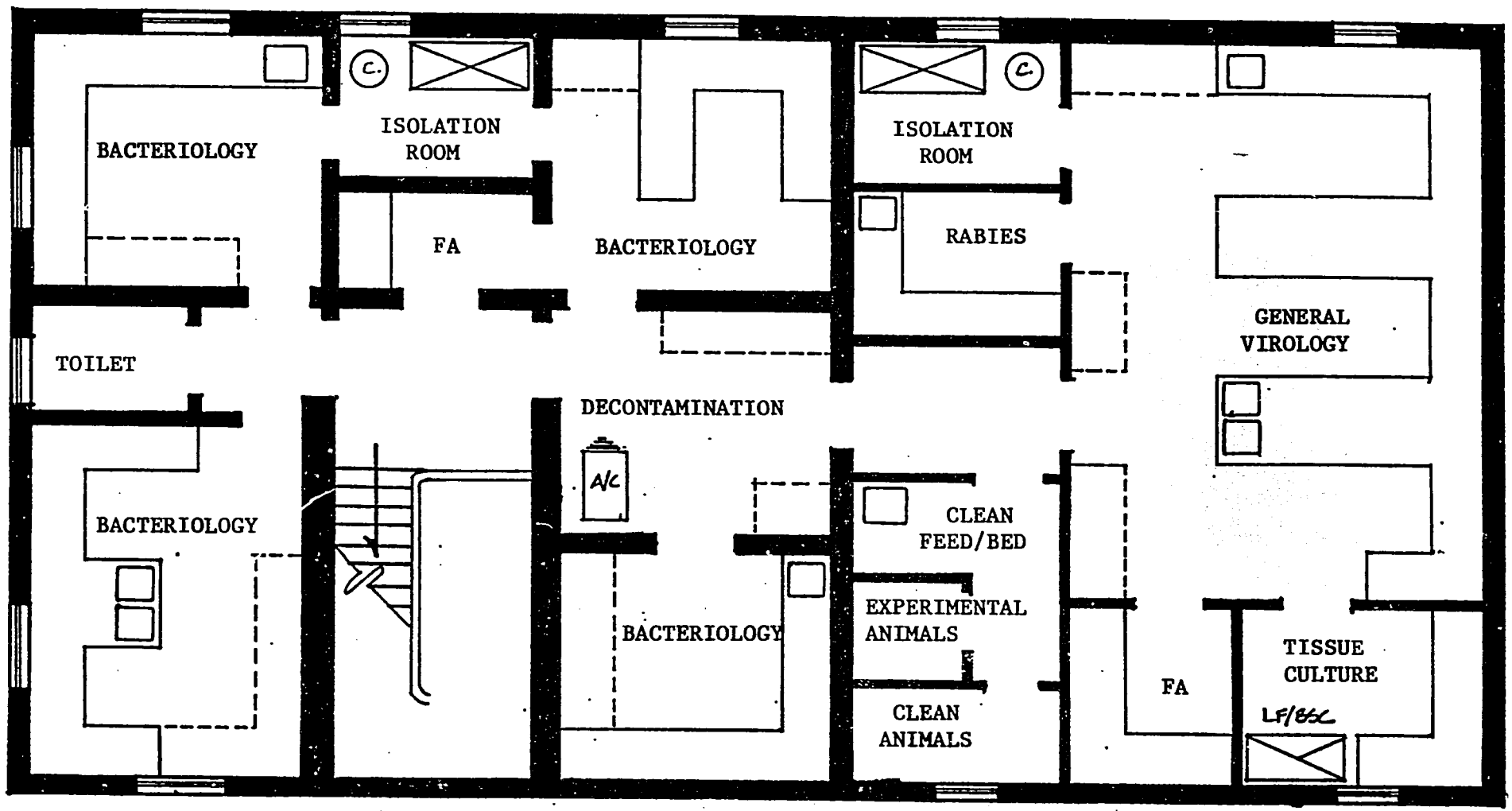
FIGURE 17

0 1 2 3 meters

GHARBIA PROVINCIAL LABORATORY

MINISTRY OF HEALTH

TANTA, EGYPT



SECOND FLOOR PLAN

FIGURE 18

Gharbia Provincial Laboratory - Preliminary Cost Estimate

The following funding breakdown is based on an estimation of current construction cost in Cairo and the assumption that all work will be accomplished by private construction contractors.

Estimates are computed in Egyptian pounds.

Renovation

Construction Cost (500 sq. mts. x L.E. 200)	100,000
Design & Construction Supervision (10% of Construction Cost)	10,000
Contingencies (5% of Construction Cost)	5,000
Total Renovation L.E.	115,000

New Extension

Construction Cost (300 sq. mts. x L.E. 300)	102,000
Design & Construction Supervision (10% of Construction Cost)	10,200
Contingencies (5% of Construction Cost)	5,100
Total New Extension L.E.	117,300
Total Renovation & Extension Funding L.E.	232,300
	(or $ 332,189)

Various constraints in estimating construction cost were mentioned previously with the CPHL estimate. These same constraints also apply to this estimate.

CPHL, Gharbia Provincial Laboratory - Summary

The implementation of facility planning recommendations for both laboratories should be coordinated by an architect or architects working closely with representatives of the respective facility.

Although these recommendations will greatly improve both facilities, long-range plans should include the design and construction of a new laboratory building for CPHL that is efficiently designed and capable of being flexible to accommodate changing program activities. This is more important at CPHL since major facility changes cannot be easily made and the extensions are more influenced by the existing structure.

The Gharbia Provincial Laboratory with its recommended extension will be more adaptable to future changes. If modular flexibility is a part of a laboratory, it must be built from the ground to the top floor, incorporating various modular features which allow future changes at minimal cost. Such an arrangement is not possible in the present CPHL building, nor will it be possible after the renovation and expansion.

CONCLUDING STATEMENT

This report completes the second phase of Project 03-337-C. If there are any questions regarding the report herein or need for further information, the Project Officer should be contacted. In addition, any other explanations as to findings and recommendations can be rendered by the Project Officer during his visit in the third phase of the Project. The schedule for concluding the project is:

Third Phase - October 1979 - Visit to Egypt by United States Project Officer for follow-up and assistance in implementation of recommendations. A further plan of action will be drawn up at this time.

Final Phase - Spring 1980 - Visit to Egypt by United States Project Officer and one other member of the U. S. project team (Medical and Epidemiology Consultant) for follow-up in Cairo and in provincial facilities in Gharbia. At this time, if project funds are available, and if the Undersecretary determines the need, the laboratory system will be studied in two additional provinces, diverse in location and health conditions from that of Gharbia Province. Gharbia, with its additional needs, as shown in this report, differs from the Aswan area, Suez Canal area, or an area deep in the western desert. This will be discussed in detail during the Project Officer's visit in October 1979. At the end of the final phase, an evaluation will be prepared as to the need for further projects, and the cost-benefit of such an expansion.

The United States project team appreciates the fine effort and cooperation of the Egyptian team as well as all personnel contacted in Cairo and Gharbia Province during the first and second phases of this Project.

APPENDIX I

This Appendix lists 248 items of laboratory equipment and 34 microscopes used in the Central Public Health Laboratories (CPHL). Each item is listed by the organization to which it is assigned and the country from where it was obtained. The fact that 14 countries are represented in this listing seriously affects standardization - a prerequisite for proper laboratory response, and proper efficiency and effectiveness in the delivery of laboratory services. Furthermore, almost half of the 248 items of equipment are between 10 and 45 years old (23%, 10-14 years old, and 25%, 15-45 years old). Other items of significance in this tabular listing are: Special training is needed to maintain 27% of these 248 pieces. The replacement cost of the equipment on which special maintenance training is needed is 41,500 LE. Of the 248 pieces, 15% are inoperative. The replacement cost of the inoperative equipment is 24,100 LE. Obsolete equipment amounts to 27% of the 248 pieces, at a replacement cost of 33,150 LE.

The percentages mentioned above are not mutually exclusive. Thus, if the CPHL replaced all its obsolete equipment at the estimated cost of 33,150 LE, there would be fewer pieces of inoperative equipment at the CPHL.

CENTRAL PUBLIC HEALTH LABORATORY - MARCH 1979

EQUIPMENT USED IN CAIRO, EGYPT

Organization and Equipment Assigned	No.	Age (Years)	Country Where Equipment Made	Downtime Often (O) Normal (N) Seldom (S)	Is Maintenance Critical For This Equipment	Are There Personnel Qualified To Maintain This Equipment	Is Any Special Training Needed by CPHL Personnel To Maintain This Equipment	Are Spare Parts Easy To Obtain For This Equipment
MICROBIOLOGY								
Tuberculosis								
Refrigerator	11	8	Egypt	N	9 - Yes 2 - No	Yes	No	Yes
Incubator	8	8	5 - Egypt 3 - W. Germany	5 Egypt - N 3 W. Germany - S	Yes	Yes	No	5 - Egypt - Yes 3 - W.Germ - No
Centrifuge	6	10	USA	S	5 - Yes 1 - No	Yes	No	No
Autoclave	9	10	2 - Egypt 3 - England 4 - USA	N	5 - Yes 4 - No	No	Yes	2 - Egypt - Yes 7 - England & USA - No
Distillator	2	15	England	N	1 - Yes 1 - No	Yes	No	No
Drying Furnace	12	9-8 3-15	9 - Egypt 3 - Denmark	N	Yes	Yes	No	9 - Egypt - Yes 3 - Denmark - No
Cold Room	1	20	England	O	No	Yes	No	No
Incubator Room	1	20	England	N	No	Yes	No	No
Safety Hood	4	20	Egypt	S	Yes	Yes	No	Yes
VD & Spirochete								
Microscope	4		2 - Czechoslovakia 2 - Poland					No
Viral Serology								
Centrifuge	1	10	E. Germany	S	Yes	Yes	No	No
Incubator	1	10	Egypt	N	Yes	Yes	No	Yes
Freeze Dryer	1	2	England	N	No	No	Yes	No
Refrigerator	1	30	USA	S	Yes	Yes	No	No
General Bactoriology								
Incubator	9	2-5 2-6 1-10 2-25 2-40	(1 - Egypt (1 - England Egypt W. Germany England England	1 - Egypt - N 1 - England - S 2 - Egypt - N 1 - W. Germany-S 4 - England - N	Yes	Yes	No	Egypt - Yes England) - No W. Germany)
Centrifuge	5	3-3 1-4 1-10	(1 - England (1 - Sweden (1 - W. Germany England USA	S	Yes	Yes	No	Egypt - Yes England) Sweden) - No W. Germany) USA)
Centrifugal Freeze Dryer	1	4	England	N	No	No	Yes	No
Refrigerator	11	6-5 2-10 2-20 1-45	(3 - Egypt (2 - Sweden (1 - USA 2 - USA (1 - Egypt (1 - England 1 - USA	3 - USA) 4 - Egypt) - S 2 - Sweden) 1 - England) 1 - USA - O	Yes	Yes	No	Egypt - Yes Sweden) USA) - No England)
Electrical Balance	3	2-3 1-8	2 - W. Germany 1 - Poland	2 - W. Germany-S 1 - Poland - N	Yes	Yes	No	No
Distillator	2	1-7 1-40	1 - Holland 1 - England	1 - England - O 1 - Holland - O	Yes	Yes	No	No
Autoclave	2	5	Russia	N	Yes	Yes	No	No
Drying Furnace	2	6	Egypt	S	Yes	Yes	No	Yes
Electrical Furnace	1	12	England	N	Yes	Yes	No	No
Microscope	3		1 - E. Germany 2 - Czechoslovakia					No

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CENTRAL PUBLIC HEALTH LABORATORY - MARCH 1979

EQUIPMENT USED IN CAIRO, EGYPT

Organization and Equipment Assigned	No.	Age (Years)	Country Where Equipment Made	Downtime Often (O) Normal (N) Seldom (S)	Is Maintenance Critical For This Equipment	Are There Personnel Qualified To Maintain This Equipment	Is Any Special Training Needed by CPHL Personnel To Maintain This Equipment	Are Spare Parts Easy To Obtain For This Equipment
MICROBIOLOGY (Cont.)								
Water & Food								
Incubator	7	3-2 2-5 2-9	2 - Egypt 2 - W. Germany 3 - England	2 - Egypt - O 1 - W. Germ. - S 1 - W. Germ. - N 3 - England - S	Yes	Yes	No	Egypt - Yes W. Germ.) - No England)
Autoclave	2	1-5 1-15	1 - England 1 - Russia	1 - England - S 1 - Russia - O	Yes	Yes	1 - England - No 1 - Russia - Yes	No
Electric Balance	1	15	Poland	S	Yes	Yes	No	No
pH Meter	1	15	USA	N	Yes	Yes	Yes	No
Oven	1	15	Holland	S	Yes	Yes	No	No
Water Bath	1	10	W. Germany	N	No	Yes	No	No
Refrigerator	2	1-15 1-20	1 - Egypt 1 - USA	N	Yes	Yes	No	Egypt - Yes USA - No
Drying Furnace	3	10	England	S	Yes	Yes	No	No
Microscope	3		1 - Japan 1 - Czechoslovakia 1 - Poland					No
CLINICAL PATHOLOGY								
Biochemistry								
Microscope	1		Japan					No
Cold Room	1	5 Mos.	USA	S	Yes	Yes	No	Yes
Colorimeter	1	20	USA	S	Yes	Yes	No	No
Centrifuge	2	1-5 1-20	1 - E. Germany 1 - England	S	Yes	Yes	No	No
Spectrophotometer	2	1-8 1-20	1 - England 1 - USA	S	Yes	No	Yes	No
Electrical Balance	1	10	W. Germany	S	Yes	Yes	No	No
pH Meter	1	20	USA	Broken	Yes	No	Yes	No
Flame Photometer	2	1-4 1-10	1 - England 1 - E. Germany	S	Yes	Yes	No	E. Germ. - No England - Yes
Refrigerator	2	1-15 1-20	USA	S	Yes	Yes	No	No
Distillator	1	20	England	N	Yes	Yes	No	No
Double Distillator	1	5	Poland	N	Yes	Yes	No	No
Incubator	1	1	England	N	Yes	Yes	No	No
Deep Freezer	1	25	USA	N	Yes	Yes	No	No
BMR	1	20	USA	Broken	Yes	Yes	No	No
Photoelectric Colorimeter	1	2	England	S	Yes	No	Yes	Yes
Unimeter	1	6 Mos.	USA	S	Yes	No	Yes	No
Hematology								
Spectrophotometer	1	5	Sweden	S	Yes	Yes	No	No
Shaker	2	5	Sweden	S	Yes	Yes	No	No
Electrophoresis	1	5	England	S	Yes	No	Yes	No
Sensitivity Balance	1	15	USA	S	Yes	Yes	No	No
Deep Freezer	1	30	Egypt	N	Yes	Yes	No	Yes
Micro Centrifuge	1	5	Sweden	S	Yes	Yes	No	No
Refrigerator	1	20	Egypt	S	Yes	Yes	No	Yes
Centrifuge	1	30	E. Germany	S	Yes	Yes	No	No
Electric Furnace	1	15	Sweden	S	Yes	Yes	No	No
Colorimeter	1	15	USA	S	Yes	No	Yes	No

CENTRAL PUBLIC HEALTH LABORATORY - MARCH 1979

EQUIPMENT USED IN CAIRO, EGYPT

Organization and Equipment Assigned	No.	Age (Years)	Country Where Equipment Made	Downtime Often (O) Normal (N) Seldom (S)	Is Maintenance Critical For This Equipment	Are There Personnel Qualified To Maintain This Equipment	Is Any Special Training Needed by CPHL Personnel To Maintain This Equipment	Are Spare Parts Easy To Obtain For This Equipment
CLINICAL PATHOLOGY (Cont)								
Hematology (Cont.)								
Water Bath	2	10	W. Germany	S	Yes	Yes	No	No
Incubator	1	10	Denmark	S	Yes	Yes	No	No
Microscope	4		3 - Japan 1 - Czechoslovakia					No
Histopathology								
Electric Furnace	2	20	1 - England 1 - W. Germany	S	Yes	Yes	No	No
Centrifuge	1	12	England	S	Yes	Yes	No	No
Refrigerator	2	1-20	1 - Egypt 1 - USA	Egypt - S USA - N				Egypt - Yes USA - No
Microtome	3	1-1 2-25	1 - India 2 - England	India - S England - N	Yes	No	Yes	No
Knife Sharpener	2	1-4 Mos. 1-4	1 - USA 1 - India	USA - S India - O	Yes	No	Yes	No
Histokonate	1	10	England	S	Yes	No	Yes	No
Microscope	8		3 - Japan 2 - W. Germany 3 - Russia					No
SANITARY CHEMISTRY								
Water								
Electric Balance	5	3	Poland	S	Yes	No	Yes	No
Muffle Furnace	1	5	Egypt	S	Yes	No	Yes	No
Drying Furnace	7	1-7 6-10	1 - Egypt 6 - Sweden	Egypt - S Sweden - N	Yes	No	Yes	Egypt - Yes Sweden - No
Cooling Incubator	1	7	Egypt	N	Yes	No	Yes	Yes
Refrigerator	4	2-7 2-20	2 - Egypt 2 - USA	S	Yes	Yes	No	Egypt - Yes USA - No
Distillator	2	10	England	Broken	Yes	Yes	No	No
Centrifuge	1	10	E. Germany	S	Yes	No	Yes	No
Water Bath	1	10	England	S	Yes	Yes	No	No
Spectrophotometer	1	7	England	S	Yes	No	Yes	No
Atomic Absorption	1	6	England	N	Yes	Yes	Yes	No
Flame Photometer	1	4	England	S	Yes	Yes	Yes	No
pH Meter	1	13	USA	Broken	Yes	Yes	No	No
Polygraph	1	7	England	N	Yes	Yes	Yes	No
Microscope	3		Japan					No
Food								
Drying Furnace	9	2-1 3-8 1-10 2-15 1-20	5 - Denmark 3 - W. Germany 1 - England	4 - Denmark - S 3 - W. Germany - S 1 - England - S 1 - Denmark - N	Yes	Yes	Yes	No
Muffle Furnace	8	1-6 7-10	3 - Italy 2 - Egypt 2 - W. Germany 1 - E. Germany	N	Yes	No	Yes	No
Refrigerator	12	1-2 3-5 3-6 1-10 2-15 1-20 1-25	8 - USA 4 - Egypt	8 - USA - S 3 - Egypt - S 1 - Egypt - N	5 - USA - Yes 3 - Egypt - Yes 3 - USA - No	Yes	No	4 - Egypt - Yes 8 - USA - No
Electric Balance	13	2-7 8-8 3-20	5 - E. Germany 5 - Poland 2 - W. Germany 1 - Italy	S	Yes	Yes	No	No
Sacre Meter	2	9	England	S	Yes	Yes	No	No
Refractive Index	2	8	E. Germany	S	No	Yes	No	No

CENTRAL PUBLIC HEALTH LABORATORY - MARCH 1979

EQUIPMENT USED IN CAIRO, EGYPT

Organization and Equipment Assigned	No.	Age (Years)	Country Where Equipment Made	Downtime Often (O) Normal (N) Seldom (S)	Is Maintenance Critical For This Equipment	Are There Personnel Qualified To Maintain This Equipment	Is Any Special Training Needed by CPHL Personnel To Maintain This Equipment	Are Spare Parts Easy To Obtain For This Equipment
SANITARY CHEMISTRY (Cont)								
Food (Cont.)								
Water Bath	4	1-1 2-8 1-10	1 - W. Germany 3 - England	S	2 - England - Yes 1 - W.Germ. - Yes 1 - England - No	Yes	No	No
Colorimeter	2	10	1 - England 1 - W. Germany	England - S W. Germ.- Broken	Yes	No	Yes	No
pH Meter	1	8	USA	N	Yes	Yes	No	No
Centrifuge	2	1-7 1-10	E. Germany	1 - S 1 - N	Yes	Yes	No	No
Incubator	1	7	Egypt	N	Yes	Yes	No	Yes
Electro Thermal	1	2	W. Germany	S	Yes	Yes	No	No
Zeiss Apparatus(Oils)	3	30	E. Germany	S	Yes	No	Yes	No
Microscope	7		2 - Czechoslovakia 2 - W. Germany 1 - Russia 1 - Poland 1 - Japan					No
TOXICOLOGY								
Water Bath	1	1	W. Germany	S	Yes	Yes	No	No
Drying Furnace	2	1	1 - England 1 - W. Germany	S	Yes	Yes	No	No
Electro Thermal	1	2	W. Germany	S	Yes	Yes	No	No
Refrigerator	1	2	Egypt	S	Yes	Yes	No	Yes
Microscope	1		Poland					No

CENTRAL PUBLIC HEALTH LABORATORY - MARCH 1979

EQUIPMENT USED IN CAIRO, EGYPT

Organization and Equipment Assigned	No.	Age (Years)	Country Where Equipment Made	Is This Equipment Inoperative	Is This Equipment Obsolete	Is This Equipment Surplus	Replacement Cost (LE)
MICROBIOLOGY							
Tuberculosis							
Refrigerator	11	8	Egypt	No	No	9 - No 2 - Yes	200 Ea.
Incubator	8	8	5 - Egypt 3 - W. Germany	No	No	No	400 Ea.
Centrifuge	6	10	USA	2 - No 4 - Yes	Yes	5 - No 1 - Yes	650 Ea.
Autoclave	9	10	2 - Egypt 3 - England 4 - USA	3 - USA - No 1 - England - No 1 - Egypt - No 1 - USA - Yes 2 - England - Yes 1 - Egypt - Yes	No	4	700 Ea.
Distillator	2	15	England	1 - No 1 - Yes	Yes	1 - No 1 - Yes	250 Ea.
Drying Furnace	12	9-8 3-15	9 - Egypt 3 - Denmark	11 - No 1 - Yes	9 - Egypt - No 3 - Denmark - Yes	No	Egypt - 350 Ea. Denmark - 400 Ea.
Cold Room	1	20	England	Yes	No	No	5,000
Incubator Room	1	20	England	No	No	No	3,500
Safety Hood	4	20	Egypt	2 - No 2 - Yes	Yes	2 - No 2 - Yes	800 Ea.
VD & Spirochete							
Microscope	4		2 - Czechoslovakia 2 - Poland				
Viral Serology							
Centrifuge	1	10	E. Germany	No	Yes	No	E. Germany - 400
Incubator	1	10	Egypt	No	Yes	No	Egypt - 200
Freeze Dryer	1	2	England	No	No	No	England - 2,500
Refrigerator	1	30	USA	No	No	No	USA - 450
General Bacteriology							
Incubator	9	2-5 2-6 1-10 2-25 2-40	(1 - Egypt (1 - England Egypt W. Germany England England	3 - Egypt - No 1 - W. Germany - No 3 - England - No 2 - England - Yes	3 - Egypt - No 1 - W. Germ. - No 1 - England - No 4 - England - Yes	No	Egypt - 200 Ea. England) - 400 Ea. W. Germany)
Centrifuge	5	3-3 1-4 1-10	(1 - England (1 - Sweden (1 - W. Germany England USA	2 - England - No 1 - Sweden - No 1 - W. Germany - No 1 - USA - Yes	No	No	1 - England - 300 1 - England) 1 - Sweden) - 400 Ea. 1 - W. Germany) 1 - USA)
Centrifugal Freeze Dryer	1	4	England	No	No	No	1,000
Refrigerator	11	6-5 2-10 2-20 1-45	(3 - Egypt (2-Sweden (1 - USA 2 - USA (1 - Egypt (1 - England 1 - USA	3 - USA) 4 - Egypt) - No 2 - Sweden) 1 - England) 1 - USA - Yes	3 - USA - Yes 4 - Egypt - No 2 - Sweden - No 1 - England - No 1 - USA - No	No	4 - Egypt - 200 Ea. 2 - Sweden - 400 Ea. 4 - USA) 1 - England) - 450 Ea.
Electrical Balance	3	2-3 1-8	2 - W. Germany 1 - Poland	No	1 - Poland - Yes 2 - W. Germ. - No	No	1 - Poland - 150 2 - W.Germ.- 250 Ea.
Distillator	2	1-7 1-40	1 - Holland 1 - England	Yes	Yes	No	250 Ea.
Autoclave	2	5	Russia	No	No	No	500
Drying Furnace	2	6	Egypt	No	No	No	400
Electrical Furnace	1	12	England	No	Yes	No	300
Microscope	3		1 - E. Germany 2 - Czechoslovakia				

CENTRAL PUBLIC HEALTH LABORATORY - MARCH 1975

EQUIPMENT USED IN CAIRO, EGYPT

Organization and Equipment Assigned	No.	Age (Years)	Country Where Equipment Made	Is This Equipment Inoperative	Is This Equipment Obsolete	Is This Equipment Surplus	Replacement Cost (LE)
MICROBIOLOGY (Cont.)							
Water & Food							
Incubator	7	3-2 2-5 2-9	2 - Egypt 2 - W. Germany 3 - England	1 - Egypt) 2 - W. Germ.) - No 3 - England) 1 - Egypt - Yes	2 - Egypt - Yes 1 - W. Germ. - Yes 3 - England - No 1 - W. Germany - No	No	2 - Egypt - 200 Ea. 3 - England) - 400 Ea. 1 - W. Germany) 1 - W. Germany - 350
Autoclave	2	1-5 1-15	1 - England 1 - Russia	No	1 - England - No 1 - Russia - Yes	No	1 - England - 400 1 - Russia - 500
Electric Balance	1	15	Poland	No	Yes	No	150
pH Meter	1	15	USA	No	Yes	No	250
Oven	1	15	Holland	No	Yes	No	350
Water Bath	1	10	W. Germany	No	Yes	No	300
Refrigerator	2	1-15 1-20	1 - Egypt 1 - USA	Egypt - No USA - Yes	Yes	1 - Egypt - No 1 - USA - Yes	1 - Egypt - 200 1 - USA - 450
Drying Furnace	3	10	England	No	Yes	1 - Yes 2 - No	400 Ea.
Microscope	3		1 - Japan 1 - Czechoslovakia 1 - Poland				
CLINICAL PATHOLOGY							
Biochemistry							
Microscope	1		Japan				
Cold Room	1	5 Mos.	USA	No	No	No	5,000
Colorimeter	1	20	USA	No	Yes	No	500
Centrifuge	2	1-5 1-20	1 - E. Germany 1 - England	E. Germ. - No England - Yes	E. Germ. - No England - Yes	No	400 Ea.
Spectrophotometer	2	1-8 1-20	1 - England 1 - USA	England - No USA - Yes	England - No USA - Yes	No	700 Ea.
Electrical Balance	1	10	W. Germany	No	No	No	250
pH Meter	1	20	USA	Yes	Yes	No	300
Flame Photometer	2	1-4 1-10	1 - England 1 - E. Germany	England - No E. Germ. - Yes	England - No E. Germ. - Yes	No	1,000 Ea.
Refrigerator	2	1-15 1-20	USA	No	Yes	No	450 Ea.
Distillator	1	20	England	Yes	Yes	No	250
Double Distillator	1	5	Poland	No	Yes	No	400
Incubator	1	1	England	No	No	No	400
Deep Freezer	1	25	USA	No	Yes	No	900
BMR	1	20	USA	Yes	Yes	No	500
Photoelectric Colorimeter	1	2	England	No	No	No	600
Unimeter	1	6 Mos.	USA	No	No	No	800
Hematology							
Spectrophotometer	1	5	Sweden	No	No	No	600
Shaker	2	5	Sweden	No	No	No	400
Electrophoresis	1	5	England	No	No	No	500
Sensitivity Balance	1	15	USA	No	No	No	250
Deep Freezer	1	30	Egypt	No	No	Yes	900
Micro Centrifuge	1	5	Sweden	No	No	No	400
Refrigerator	1	20	Egypt	No	No	No	200
Centrifuge	1	30	E. Germany	No	No	No	250
Electric Furnace	1	15	Sweden	No	No	No	400
Colorimeter	1	15	USA	No	No	No	600

CENTRAL PUBLIC HEALTH LABORATORY - MARCH 1979

EQUIPMENT USED IN CAIRO, EGYPT

Organization and Equipment Assigned	No.	Age (Years)	Country Where Equipment Made	Is This Equipment Inoperative	Is This Equipment Obsolete	Is This Equipment Surplus	Replacement Cost (LE)
CLINICAL PATHOLOGY(Cont)							
Hematology (Cont.)							
Water Bath	2	10	W. Germany	No	No	No	400
Incubator	1	10	Denmark	No	No	No	400
Microscope	4		3 - Japan 1 - Czechoslovakia				
Histopathology							
Electric Furnace	2	20	1 - England 1 - W. Germany	No	No	No	400 Ea.
Centrifuge	1	12	England	No	No	No	700
Refrigerator	2	1-1 1-20	1 - Egypt 1 - USA	No	Egypt - No USA - Yes	No	Egypt - 200 USA - 450
Microtome	3	1-1 2-25	1 - India 2 - England	No	India - No England - Yes	No	India - 300 England - 400
Knife Sharpener	2	1-4 Mos. 1-4	1 - USA 1 - India	No	No	No	USA - 700 India - 400
Hiskokonate	1	10	England	No	No	No	1,000
Microscope	8		3 - Japan 2 - W. Germany 3 - Russia				
SANITARY CHEMISTRY							
Water							
Electric Balance	5	3	Poland	No	No	No	250
Muffle Furnace	1	5	Egypt	No	No	No	900
Drying Furnace	7	1-7 6-10	1 - Egypt 6 - Sweden	No	No	No	Egypt - 350 Sweden - 500 Ea.
Cooling Incubator	1	7	Egypt	No	No	No	750
Refrigerator	4	2-7 2-20	2 - Egypt 2 - USA	2 - Egypt - No 1 - USA - No 1 - USA - Yes	No	No	Egypt - 200 Ea. USA - 450 Ea.
Distillator	2	10	England	Yes	No	No	250 Ea.
Centrifuge	1	10	E. Germany	No	No	No	350
Water Bath	1	10	England	No	No	No	350
Spectrophotometer	1	7	England	No	No	No	900
Atomic Absorption	1	6	England	No	No	No	1,500
Flame Photometer	1	4	England	No	No	No	1,000
pH Meter	1	13	USA	Yes	No	No	400
Polygraph	1	7	England	No	No	No	700
Microscope	3		Japan				
Food							
Drying Furnace	9	2-1 3-8 1-10 2-15 1-20	5 - Denmark 3 - W. Germany 1 - England	No	3 - Denmark - Yes 2 - Denmark - No 3 - W. Germany - No 1 - England - No	No	400 Ea.
Muffle Furnace	8	1-6 7-10	3 - Italy 2 - Egypt 2 - W. Germany 1 - E. Germany	2 - Italy - Yes 1 - E. Germany - Yes 1 - Italy - No 2 - Egypt - No 2 - W. Germany - No	3 - Italy - Yes 1 - Egypt - Yes 2 - W. Germany - Yes 1 - E. Germany - Yes 1 - Egypt - No	No	900 Ea.
Refrigerator	12	1-2 3-5 3-6 1-10 2-15 1-20 1-25	8 - USA 4 - Egypt	7 - USA - No 4 - Egypt - No 1 - USA - Yes	No	No	8 - USA - 450 Ea. 4 - Egypt - 200 Ea.

CENTRAL PUBLIC HEALTH LABORATORY - MARCH 1979

EQUIPMENT USED IN CAIRO, EGYPT

Organization and Equipment Assigned	No.	Age (Years)	Country Where Equipment Made	Is This Equipment Inoperative	Is This Equipment Obsolete	Is This Equipment Surplus	Replacement Cost (LE)
SANITARY CHEMISTRY (Cont)							
Food (Cont.)							
Electric Balance	13	2-7 8-8 3-20	5 - E. Germany 5 - Poland 2 - W. Germany 1 - Italy	3 - E. Germany - No 5 - Poland - No 2 - W. Germany - No 1 - Italy - No 2 - E. Germany - Yes	No	No	250 Ea.
Sacre Meter	2	9	England	No	No	No	400
Refractive Index	2	8	E. Germany	No	No	No	400
Water Bath	4	1-1 2-8 1-10	1 - W. Germany 3 - England	No	No	No	250 Ea.
Colorimeter	2	10	1 - England 1 - W. Germany	England - No W. Germany - Yes	No	No	500 Ea.
pH Meter	1	8	USA	No	No	No	400
Centrifuge	2	1-7 1-10	E. Germany	No	No	No	400 Ea.
Incubator	1	7	Egypt	No	No	No	200
Electro Thermal	1	2	W. Germany	No	No	No	250
Zeiss Apparatus(Oils)	3	30	E. Germany	No	Yes	No	350
Microscope	7		2 - Czechoslovakia 2 - W. Germany 1 - Russia 1 - Poland 1 - Japan				
TOXICOLOGY							
Water Bath	1	1	W. Germany	No	No	No	250
Drying Furnace	2	1	1 - England 1 - W. Germany	No	No	No	400
Electro Thermal	1	2	W. Germany	No	No	No	250
Refrigerator	1	2	Egypt	No	No	No	200
Microscope	1		Poland				

APPENDIX II

Explanation of Calculations Which Support Table XVII (Workload, Staffing, and Productivity - Central Public Health Laboratories - 1978) and Table XIX (Workload, Staffing, and Productivity - Work Efficiency - Tanta Laboratory - 1978)

Calculation of productivity and costing estimates requires the combination of workload data from the laboratory and data from a workload structure that assigns time units to the workload data. Primarily, the workload structure used for the calculations shown in this Appendix is one developed jointly by the Association of State and Territorial Public Health Laboratory Directors and the Center for Disease Control. Some times were obtained from the College of American Pathologists workload structure, and some times were obtained from laboratorians at the Center for Disease Control.

All procedures done at the Cairo central public health laboratories and the Tanta Laboratory for 1978 were identified by specialty. Specialties are shown in Column 1 and the procedures are shown in Column 3 of Tables A and B of this appendix. The number of each procedure accomplished is shown in Column 4.

Columns 5 and 6 show time units in minutes by batch size. Times per procedure varies with the batch size of the specimens. Time per specimen decreases generally as batch size increases because certain procedural phases can be prorated over the greater number of specimens.

The time unit (time needed to perform a procedure or test at the bench) is shown in Column 6. The time element does not include time for (1) preparing standard solutions and reagents, (2) pouring and sterilizing media for microbiological studies, (3) collecting specimens, (4) logging in and labelling specimens, (5) instrument operating or performing a step in a procedure being automatically processed (incubating time, etc.) while the laboratorian is employed on other duties, and (6) clerical work involved in reporting after results are first recorded.

Total bench work time in minutes required to perform the procedures identified is shown in Column 7. Column 7 is the product of Column 4 and Column 6.

The number of professional and technical personnel identified as being available to perform the work is shown in Column 8. To be sure a fair work time available allotment was used, calculations showing net available hours per man year are shown below. It should be noted that laborers and clerical personnel were not included in the productivity calculations.

NET AVAILABLE HOURS PER EMPLOYEE PER YEAR

(36 hours/week X 52 weeks)	=	1872 gross hours/year
(Less 3 weeks vacation)		- 108
	=	1764
(Less sick leave)		- 36
	=	1728
(Less 1/2 hour personal time per day)		- 156 *
	=	1572
(Less holidays and training)		- 72
	=	1500 Net Available Hours Per Employee Per Year

*312 work days per year

Net available professional and technical time is shown in Column 9. This is shown for each department (for example, in the CPHL, Microbiology Department had 5,940,000 minutes available in 1978), and for each section (TB had 1,530,000 minutes available in 1978).

TABLE A

CENTRAL PUBLIC HEALTH LABORATORIES - CAIRO

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
MICROBIOLOGY								
TUBERCULOSIS		Digestion/Decontamination and Concentration	11,024	11-100	10	110,240		
		Primary Culture	10,447	11-100	3	31,341		
		Ziehl-Neelsen	577	2-10	10	5,770		
		Subculture	2,057	2-10	4	8,228		
		Primary Biochemicals	346	2-10	8	2,768		
		Secondary Biochemicals	346	2-10	12	4,152		
		Indirect Drug Susceptibilities	2,039	2-10	8	16,312		
TOTAL TUBERCULOSIS	11,024					178,811	17	1,530,000
VD AND SPIROCHETE		DFATP	1,971	2-10	40	78,840		
		FTA-ABS	1,971	2-10	12	23,652		
		Microhemagglutination						
		Qualitative Manual	16,185	11-100	2	32,370		
		Quantitative Manual	1,381	2-10	3	4,143		
		RST Qualitative	25,114	> 100	1	25,114		
		RST Quantitative	1,114	2-10	1.2	1,337		

TABLE A

CENTRAL PUBLIC HEALTH LABORATORIES - CAIRO

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
VD AND SPIROCHETE (Cont.)		VDRL Qualitative	38,404	> 100	2	76,808		
		VDRL Quantitative	1,577	2-10	5	7,885		
		RPR Qualitative	29,475	> 100	1	29,475		
		RPR Quantitative	290	SS*	4	1,160		
		Wasserman Qualitative	29,475	> 100	2	58,950		
		Wasserman Quantitative	293	SS*	4	1,172		
TOTAL VD AND SPIROCHETE	53,815					340,906	10	900,000
VIRAL SEROLOGY		HI Micro Manual (1 Antigen)	1,015	2-10	7	7,105		
		HI Micro Manual (2-6 Antigens)	5,075	2-10	10	50,750		
		HI Micro Manual (Mumps)	1,015	2-10	7	7,105		
		HI Micro Semi-Automated	160	11-100	8	1,280		
		CF Micro Manual	100	2-10	15	1,500		
		CF Micro Automated	100	11-100	2	200		
		Serum Neutralization	34	SS*	25	850		
TOTAL VIRAL SEROLOGY	5,583					68,790	3	270,000

TABLE A

CENTRAL PUBLIC HEALTH LABORATORIES - CAIRO

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
GENERAL BACTERIOLOGY		Primary Cultures	33,090	> 100	3	99,270		
ENTERICS		Secondary Cultures	33,090	> 100	3	99,270		
		Subcultures	11,125	11-100	2	22,250		
		Biochemicals	3,642	11-100	6	21,852		
		API	2,702	2-10	10	27,020		
		Antigen Preparation for Serotyping	160	SS*	8	1,280		
		Agglutination Grouping	160	SS*	12	1,920		
		Complex Serotyping	160	SS*	45	7,200		
THROAT AND NASAL PHARYNGEAL		Primary Streak Plate	150	SS*	3	450		
DIPHTHERIA		Primary Culture	31,664	> 100	3	94,992		
		Biochemicals	6	SS*	5	30		
		Direct Smear	31,664	> 100	3	94,992		
URINE CULTURE AND SENSITIVITY		Quantitative Count	16,810	11-100	3	50,430		
		Definitive Identification	290	SS*	30	8,700		

TABLE A

CENTRAL PUBLIC HEALTH LABORATORIES - CAIRO

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
GENERAL BACTERIOLOGY (Cont.)		Primary Culture	18	SS*	10	180		
BLOOD		Definitive Identification	1	SS*	30	30		
SPINAL FLUIDS		Primary Culture	86	SS*	7	602		
		Definitive	3	SS*	30	90		
ANAEROBIC		Primary Culture	6,200	11-100	12	74,400		
		Definitive	1,600	2-10	45	72,000		
ANTIBIOTIC SUSCEPTIBILITY		Kirby-Bauer	368	SS*	15	5,520		
STOMACH WASH, VOMIT AND STOOLS		Specimen Preparation	1,141	2-10	12	13,692		
		Staph Typing	1,141	2-10	9	10,269		
		Anaerobic Culture	26	SS*	15	390		

TABLE A

CENTRAL PUBLIC HEALTH LABORATORIES - CAIRO

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
GENERAL BACTERIOLOGY (Cont.)		Primary Culture	56,158	> 100	3	168,474		
CHOLERA		Secondary Culture	56,158	> 100	3	168,474		
		Subculture	56,158	> 100	2	112,316		
		Biochemicals	56,158	> 100	4	224,632		
RATS FOR PLAGUE		Primary Culture	6,345	11-100	3	19,035		
FEBRILE SPINAL MENINGITIS		Primary Streak Plate	73	SS*	3	219		
		Isolation	1	SS*	3	3		
		Biochemicals	1	SS*	10	10		
		Agglutination	1	SS*	20	20		
MISCELLANEOUS		Primary Culture	684	2-10	5	3,420		
		Secondary Culture	684	2-10	5	3,420		
		Widal	204	SS*	20	4,080		
TOTAL GENERAL BACTERIOLOGY	151,662					1,410,932	20	1,800,000

TABLE A

CENTRAL PUBLIC HEALTH LABORATORIES - CAIRO

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
GENERAL BACTERIOLOGY (Cont.)								
WATER AND FOOD ANALYSIS								
FOOD		Specimen Preparation	8,592	11-100	10	85,920		
		Staphylococcus Count	4,025	11-100	10	40,250		
		Coagulase Test	386	SS*	5	1,930		
		Anaerobic Culture	4,025	11-100	10	40,250		
		Standard Plate Count	386	SS*	20	7,720		
		Coliform Count	386	SS*	20	7,720		
WATER - CHLORINATED, UNDERGROUND AND WATER FROM TAPS		Multiple Tube						
		Presumptive	10,239	11-100	5	51,195		
		Confirmed	703	2-10	3	2,109		
		Completed	11	SS*	10	110		
		MPN	10,239	11-100	15	153,585		
CARBONATED		Viable Count	5,679	11-100	3	17,037		
		Coliform	5,679	11-100	7	39,753		
JUICES AND ICE CREAM		Viable Count	314	2-10	5	1,570		
		Coliform	314	2-10	8	2,512		
TOTAL WATER AND FOOD ANALYSIS	24,824					451,661	16	1,440,000
TOTAL MICROBIOLOGY	246,908					2,451,100	66	5,940,000

TABLE A

CENTRAL PUBLIC HEALTH LABORATORIES - CAIRO

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
CLINICAL PATHOLOGY								
BIOCHEMISTRY		Blood Sugar	4,331	11-100	3	12,993		
		Urea, Urea Clearance	647	2-10	8	5,176		
		Cholesterol	246	SS*	8	1,968		
		Albumin	5	SS*	12	60		
		Chloride	132	SS*	10	1,320		
		Alkaline Phosphatase	597	2-10	7	4,179		
		Acid Phosphatase	21	SS*	10	210		
		Calcium	49	SS*	7	343		
		Sodium	8	SS*	12	96		
		Bilirubin	672	2-10	15	10,080		
		Potassium	6	SS*	12	72		
		Acetone	2,053	2-10	5	10,265		
		Complete Urine	1,210	2-10	10	12,100		
		Creatinine	289	SS*	7	2,023		
		Calcium	19	SS*	7	133		
		Occult Blood	72	SS*	5	360		
		Stone (Urinary Tract)	68	SS*	5	340		
		Pleural Effusion	1	SS*	10	10		
		Serum Bicarbonate	1	SS*	7	7		
		Globulin	2	SS*	12	24		
		CSF Chlorides	18	SS*	10	180		
		Total Protein	637	2-10	12	7,644		
		CSF Sugar	4	SS*	7	23		
		Total Lipids	5	SS*	16	80		
		Serum Uric Acid	136	SS*	7	952		
		SGPT/SGOT	80	SS*	10	800		
		Inorganic Phosphorus	52	SS*	7	364		
		Triglicerides	50	SS*	12	600		
		T_3, T_4	5,299	11-100	2	10,598		
		Serum Iron	14	SS*	10	140		
TOTAL BIOCHEMISTRY	16,724					83,145	14	1,260,000

TABLE A

CENTRAL PUBLIC HEALTH LABORATORIES - CAIRO

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
CLINICAL PATHOLOGY (Cont.)								
HEMATOLOGY		LE Cells	30	2-10	70	2,100		
		Monotest	4	SS*	2	8		
		Sickling Test	20	SS*	5	100		
		Solubility Test	20	SS*	2	40		
		Hemaglobin	348	2-10	3	1,044		
		RBC	321	2-10	7	2,247		
		WBC	432	2-10	5	2,160		
		Differential Leucocytes	429	2-10	8	3,432		
		Sedimentation Rate	1,616	2-10	5	8,080		
		Prothrombin Time	171	2-10	8	1,368		
		Platelet Count	195	2-10	5	975		
		Microhematocrit	37	2-10	2	74		
		Coagulation Time	172	2-10	10	1,720		
		Bleed Time	32	2-10	11	352		
		Bone Marrow Aspiration	3	SS*	48	144	—	
		Malaria/Filaria	6	SS*	22	132		
		Saline Osmotic Fragility for for RBC	1	SS*	60	60		
		Rheumatoid Facter	51	2-10	12	612		
		Rheumatoid Arthritis	12	SS*	15	180		
		ASO	40	2-10	12	480		
		Thromboplastin Generation Test	130	2-10	71	9,230		
		Kaolin Cephalin Clotting Time	130	2-10	10	1,300		
TOTAL HEMATOLOGY	5,297					35,838	6	540,000

TABLE A

CENTRAL PUBLIC HEALTH LABORATORIES - CAIRO

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
CLINICAL PATHOLOGY (Cont.)								
HISTOPATHOLOGY		Trimming	1,616	SS*	5	8,080		
		Processing	1,616	2-10	60	96,960		
		Cutting	1,616	2-10	25	40,400		
		Staining	1,616	2-10	15	24,240		
		Mounting	1,616	SS*	1	1,616		
		Examining	1,616	SS*	20	32,320		
TOTAL HISTOPATHOLOGY	1,616					203,616	8	720,000
TOTAL CLINICAL PATHOLOGY	23,637					322,599	28	2,520,000

TABLE A

CENTRAL PUBLIC HEALTH LABORATORIES - CAIRO

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
TOXICOLOGY								
BIOLOGICAL FLUIDS		Ethyl Alcohol Dicromate	68	SS*	60	4,080		
		Barbiturate, Drug Screen and Morphine Qualitative) Quantitative) TLC)	2,720	11-100	40	108,800		
		Alkaloids Extraction) Spot Test) Microcrystallography) TLC)	3,400	11-100	35	119,000		
		Lead and Other Heavy Metals Complexometry & Colorimetry	680	2-10	18	12,240		
		Salicylate Trinders	340	2-10	8	2,720		
		Strychnine Dichromate	27	SS*	10	270		
		Cyanide Colorimetric	20	SS*	30	600		
		Blood						
		Benzidine	20	SS*	8	160		
		Takayama	20	SS*	16	320		
		Marihuana						
		Duquenois	204	2-10	5	1,020		
		TLC	204	2-10	50	10,200		
TOTAL BIOLOGICAL FLUIDS	7,479					259,410	3	270,000

TABLE A

CENTRAL PUBLIC HEALTH LABORATORIES - CAIRO

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
TOXICOLOGY (Cont.)								
FOOD ANALYSIS		Alkaloids Extraction) Spot Test) Microcrystallography) TLC)	10,200	11-100	35	357,000		
		Lead and Other Heavy Metals Complexometry & Colorimetry	6,120	11-100	10	61,200		
		Strychnine	109	SS*	10	1,090		
TOTAL FOOD ANALYSIS	16,429					419,290	5	450,000
TOTAL TOXICOLOGY	23,908					678,700	8	720,000

TABLE A

CENTRAL PUBLIC HEALTH LABORATORIES - CAIRO

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
SANITARY CHEMISTRY								
WATER CHEMISTRY		Color	13,428	11-100	1	13,428		
		Odor	13,428	11-100	15	201,420		
		Turbidity	13,453	11-100	3	40,359		
		Settleable Solids	59	SS*	2	118		
		Suspended Solids	178	SS*	9	1,602		
		Temperature	59	SS*	1	59		
		pH	13,572	11-100	2	27,144		
		BOD	25	SS*	25	625		
		COD	25	SS*	9	225		
		Hardness	964	2-10	2	1,928		
		Alkalinity	998	2-10	4	3,992		
		Microscopic	12,455	11-100	5	62,275		
		Fluoride	153	2-10	13	1,989		
		Dissolved Solids	59	SS*	3	177		
		Total Solids	25	SS*	10	250		
		Dissolved Oxygen	25	SS*	7	175		
		Ammonia	13,419	11-100	5	67,095		
		Nitrites	13,419	11-100	5	67,095		
		Nitrates	13,419	11-100	8	107,352		
		Arsenic	25	SS*	20	500		
		Iron and Manganese	13,547	11-100	2	27,[illegible]4		
		Phenols	119	SS*	30	3,[illegible]70		
		Potassium	153	SS*	3	459		
		Total Organic Carbon	119	SS*	70	8,330		
		Sulphides	25	SS*	10	250		
		Sodium	34	SS*	25	850		

TABLE A

CENTRAL PUBLIC HEALTH LABORATORIES - CAIRO

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
SANITARY CHEMISTRY (Cont.)								
WATER CHEMISTRY (Cont.)		Silica	34	SS*	10	340		
		Calcium	34	SS*	10	340		
		Magnesium	34	SS*	10	340		
		Sulfates	34	SS*	2	68		
TOTAL WATER CHEMISTRY	13,572					639,449	14	1,260,000
FOOD CHEMISTRY		Specimen Preparation						
		Milk	9,376	11-100	10	93,760		
		Cheese	4,903	11-100	10	49,030		
		Spices	2,997	11-100	10	29,970		
		Tea and Coffee	4,612	11-100	10	46,120		
		Flour and Flour Products	21,314	11-100	10	213,140		
		Canned Foods	823	2-10	20	16,460		
		Oils and Fats	1,006	2-10	20	20,120		
		Vinegar, Salt, and Carbonated Bev.	5,466	11-100	10	54,660		
		Butter, Butter Ghee	883	2-10	20	17,660		
		Miscellaneous	19,333	11-100	10	193,330		
		Qualitative Exam						
		Milk	9,376	11-100	20	187,520		
		Cheese	4,903	11-100	20	98,060		
		Tea and Coffee	4,612	11-100	20	92,240		
		Flour and Flour Products	21,314	11-100	20	426,280		
		Canned Foods	823	2-10	20	16,460		
		Oils and Fats	1,006	2-10	20	20,120		
		Butter, Butter Ghee	883	2-10	20	17,660		
		Miscellaneous	19,333	11-100	20	386,660		

TABLE A

CENTRAL PUBLIC HEALTH LABORATORIES - CAIRO

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
SANITARY CHEMISTRY (Cont.)								
FOOD CHEMISTRY (Cont.)		Quantitative Exam						
		Milk	2,209	2-10	45	99,405		
		Cheese	801	2-10	45	36,045		
		Spices	565	2-10	45	25,425		
		Tea and Coffee	482	2-10	45	21,690		
		Flour and Flour Products	6,798	11-100	30	203,940		
		Canned Foods	169	SS*	60	10,140		
		Empty Cans	4,861	11-100	30	145,830		
		Oils and Fats	159	SS*	60	9,540		
		Vinegar, Salt, and Carbonated Bev.	5,466	11-100	30	163,980		
		Butter, Butter Ghee	186	SS*	60	11,160		
		Miscellaneous	1,831	2-10	45	82,395		
TOTAL FOOD CHEMISTRY	69,890					2,788,800	42	3,780,000
TOTAL SANITARY CHEMISTRY	83,462					3,428,249	56	5,040,000

* Single Sample

TABLE B

TANTA LABORATORY

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
GENERAL BACTERIOLOGY								
Blood Cultures	2,863	Primary Culture	2,863	11-100	8	22,904		
		Definitive Identification	159	2-10	25	3,975		
Widal and Weil-Felix	2,496	Agglutination	2,496	11-100	15	37,440		
Malta Agglutination	7	Agglutination	7	SS*	20	140		
FTA-ABS	32		32	SS*	12	384		
VDRL	4,760	Qualitative	4,760	> 100	2	9,520		
Urine for Parasites	123	Quantitative Count	123	2-10	5	615		
		Definitive Identification	12	SS*	30	360		
Urine Culture for Salmonella	13,087	Quantitative Court	13,087	> 100	3	39,261		
		Definitive Identification	1,000	11-100	25	25,000		
Urine Culture for Sensitivity	95	Quantitative Court	95	2-10	5	475		
		Definitive Identification	10	SS*	30	300		
Urine for Koch's Bacillus	1	Quantitative Court	1	SS*	10	10		
		Definitive Identification	1	SS*	30	30		
Stools for Parasites	9	Microscopic Examination	9	SS*	12	108		

TABLE B

TANTA LABORATORY

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
GENERAL BACTERIOLOGY (Cont.)								
Stools for Salmonella and Shigella	24,024	Primary Culture	24,024	> 100	3	72,072		
		Secondary Culture	21,622	> 100	3	64,866		
		Biochemicals	2,162	2-10	8	17,296		
		Agglutination Grouping	2,162	2-10	10	21,620		
Spinal Fluids	254	Primary Culture	254	2-10	5	1,270		
		Definitive	25	SS*	30	750		
Culture for Diphtheria Swabs	21,907	Primary Culture	21,907	> 100	2	43,814		
Rats for Plague	311	Primary Culture	311	2-10	5	1,555		
		Biochemicals	31	SS*	10	310		
		Animal Inoculation	31	SS*	25	775		
Swabs and Water for Vibrios	63,631	Primary Culture	63,631	> 100	2	127,262		
		Secondary Culture	57,267	> 100	2	114,534		
		Subculture	5,727	> 100	2	11,540		
		Biochemicals	5,727	> 100	3	17,181		
		Agglutination Grouping	5,727	> 100	5	28,635		
Miscellaneous	283	Primary Culture	283	2-10	5	1,415		
		Secondary Culture	283	2-10	5	1,415		

TABLE B

TANTA LABORATORY

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
WATER AND FOOD ANALYSIS								
Food	2,957	Specimen Preparation	2,957	> 100	8	23,656		
		Staphylococcus Count	1,390	> 100	8	13,900		
		Coagulase Test	118	SS*	5	590		
		Anaerobic Culture	139	2-10	58	8,062		
		Standard Plate Count	118	SS*	20	2,360		
		Coliform Count	118	SS*	20	2,360		
Water	5,972	Multiple Tube						
		Presumptive	5,972	11-100	5	29,860		
		Confirmed	418	SS*	3	1,254		
		Completed	7	SS*	10	70		
		MPN	3,000	11-100	15	45,000		
TOTAL MICROBIOLOGY	145,308					793,944	12	990,000

TABLE B

TANTA LABORATORY

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
CLINICAL PATHOLOGY								
Biochemistry	1,500	Blood Sugar	780	2-10	5	3,900		
		Urea	120	2-10	8	960		
		Creatinine	60	SS*	10	600		
		SGPT/SGOT	14	SS*	10	140		
		SAP	4	SS*	25	100		
		Serum Uric Acid	30	SS*	10	300		
		Complete Urine	210	2-10	5	1,050		
		CSF Chemical	4	SS*	7	28		
		Bilirubin	120	2-10	5	600		
		Cholesterol	30	SS*	8	240		
		SAKP	120	2-10	20	2,400		
		BMR	4	SS*	40	160		
		Thymol Flocc. and Turbidity	4	SS*	9	36		
Hematology	475	CBC	100	2-10	1	100		
		Sedimentation Rate	300	2-10	5	1,500		
		Coagulation	28	SS*	10	280		
		Prothrombine	28	SS*	8	224		
		Blood Parasites	12	SS*	20	240		
		Fragility RBC	1	SS*	60	60		
		Bleeding Time	6	SS*	11	66		
TOTAL CLINICAL PATHOLOGY	1,975					12,984	4	360,000

TABLE B

TANTA LABORATORY

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
SANITARY CHEMISTRY								
Food Chemistry	22,606	Specimen Preparation					11	990,000
		Oils & Fats	452	2-10	20	9,040		
		Milk	6,782	11-100	10	67,820		
		Tea & Coffee	2,261	11-100	10	22,610		
		Spices	1,356	11-100	10	13,560		
		Vinegar	2,487	11-100	10	24,870		
		Sugar and Sugar Products	9,268	11-100	10	92,680		
		Qualitative Exam						
		Oils & Fats	452	2-10	20	9,040		
		Milk	6,782	11-100	20	135,640		
		Tea & Coffee	2,261	11-100	20	45,220		
		Sugar and Sugar Products	9,268	11-100	20	185,360		
		Quantitative Exam						
		Oils & Fats	72	SS*	60	4,320		
		Milk	1,628	11-100	30	48,840		
		Tea & Coffee	226	2-10	45	10,170		
		Spices	258	2-10	45	11,610		
		Vinegar	2,487	11-100	30	74,610		
		Sugar and Sugar Products	834	2-10	45	37,530		

TABLE B

TANTA LABORATORY

1978

Specialty	Number of Specimens or Samples	Procedures	Number	Batch Size	Time Unit	Bench Work Time Required (Minutes)	Number of Professional & Technical Personnel	Professional & Technical Time Available (Minutes)
SANITARY CHEMISTRY (Cont.)								
Water Chemistry	774	Taste and Odor	774	11-100	15	11,610	10	900,000
		TDS	50	SS*	3	150		
		Ammonia	774	11-100	8	6,192		
		Nitrites	774	11-100	7	5,418		
		Nitrates	774	11-100	8	6,192		
		Chlorides	50	SS*	10	500		
		Total Alkalinity	50	SS*	5	250		
		Total Hardness	50	SS*	5	250		
		Calcium	10	SS*	14	140		
		Magnesium	10	SS*	13	130		
		Iron	774	11-100	10	7,740		
		Manganese	774	11-100	10	7,740		
		Residual Chlorine	10	SS*	10	100		
		Microscopic	774	11-100	5	3,870		
		pH	774	11-100	2	1,548		
		Color	774	11-100	1	774		
		Settleable Solids	10	SS*	2	20		
		Suspended Matters	20	SS*	9	180		
		Sulfides	10	SS*	10	100		
		Dissolved Oxygen	10	SS*	7	70		
		Oxygen Consumed	10	SS*	30	300		
		BOD	10	SS*	25	250		
		Oils & Fats	10	SS*	25	250		
		Cyanides	10	SS*	25	250		
TOTAL SANITARY CHEMISTRY	23,380					846, 44	21	1,890,000

* Single Sample

APPENDIX III

Test Cost Estimation

Preventive Maintenance System

A Manual System for Storage and Inventory Control of Laboratory Supplies

Simplification and Standardization of Laboratory Supplies

Service Levels in a Hospital Laboratory

Test Cost Estimation

A. Cost Centers

The first step in estimating cost of tests is to identify cost centers. A cost center is a definable activity that produces a product or provides a service and in doing so incurs costs for salaries, supplies, travel, etc. In the CPHL, the Microbiology Department, for example, is a definable cost center that provides a service or produces a product. Also, at the CPHL, the Engineering Department is another definable cost center that provides a service to other cost centers in the CPHL.

There are two types of cost centers: (1) revenue (direct costs) centers and (2) nonrevenue (indirect and support costs) centers. Revenue centers are those activities that provide services or products to users outside the organization and for which revenue could be gained if charges were made. Whether or not the charge for services is actually made is immaterial to the definition. For example, the CPHL's Sanitary Chemistry Department is a revenue center even if a direct fee is not charged for any tests done there.

Nonrevenue centers are those activities that support other activities within the organization and for which revenue could not be gained. For example, the Engineering Department supports the other cost centers within the CPHL but provides no outside services or products.

B. Accumulation

Once cost centers are designated, costs can be accumulated. Accumulation means that costs are directly identified by cost center. The primary target for accumulation are personnel costs (salaries, benefits, and overhead), because this expense usually constitutes the largest amount in the total operating cost of a laboratory. Table A provides a format for accumulation, including a column for each cost center and a line for each type of expense.

Salaries, benefits, and overhead for each cost center would be recorded on line 02 of Table A. Supply costs by cost center would be recorded on line 03. Supply costs are the second largest amount in the total operating cost of a laboratory. No costs were supplied to the CDC team. Costs used in this example are for illustrative purposes only.

There are other expenses which should be accumulated, and accumulation will improve the accuracy of the cost-per-test estimate. However, to keep the methodology simple we will accumulate only the above two items. Total accumulated expenses will then be recorded by cost center on line 04.

C. Allocation

Costs which cannot be identified as incurred by a particular cost center must be allocated on some fair share basis. All other expenses of the laboratory will be grouped, for simplicity, and allocated. The basis of allocation used will be the percent of personnel in each cost center. The calculations for these are shown in Table B, and the results are recorded on line 06 of Table A with the basis for allocation identified.

Other bases of allocation could include (a) number of specimens received, (b) number of tests done, (c) number of workload units produced, (d) square footage assigned to each cost center, or (e) estimations and judgments by those most familiar with the costs.

Total allocated expenses are recorded on line 07 of Table A. Total accumulated and total allocated costs are recorded on line 08 of Table A.

As the CPHL staff becomes familiar with this cost estimation methodology, they will identify the allocation items and match them with appropriate allocation bases. They will also identify specific items of the Other category as accumulation items (e.g., travel, postage, etc.) and move those items to the accumulation section of Table A.

D. Reapportionment

Now the costs of the nonrevenue cost centers must be transferred to the revenue centers they serve. Once this is done, the CPHL staff will have an estimate of the total cost of each revenue producing cost center. This aspect of building the cost accounting system is called reapportionment.

Bases used for reapportionment are the services provided by a nonrevenue cost center to all other cost centers, including other nonrevenue centers as well as the revenue centers. The reapportionment procedure is depicted in Table C. The data in the column titled Total Accumulated and Total Allocated Expenses is obtained from line 08, Table A. The nonrevenue cost center listed first is that of the Director's Office. The reapportionment percentage estimates used would be made by the Director, CPHL. An example of this type data is found in Table D. These percentages are put in the % column of the Director's Office Reapportioned Cost column.

The method of determining the average percent of time for the staff of the Director's Office is most easily done by adding the percentage figure for each person, or groups of persons, and dividing the total percent of service by the number of people, or groups of people. For example, in Table D note that the two breakdowns of the Director's staff are shown in the example as spending 5% and 10% of their respective time serving the Microbiology Department cost center. The total percent of service (15%) is divided by the number of people or groups of people shown in the Director's Office (namely 2), for an adjusted percent of service of 7.5%.

Next, one must calculate the proportionate amount of the Director's Office total accumulated and allocated expense to be added to each of the other cost

centers. For example, in Table D staff of the Director's Office are shown in this example as providing 50% of their time to support the Administration Department. This amount (50% of 4629 = 2315) is placed in the proper line of the column headed Monies in the Director's Office Reapportioned Cost column. Likewise, the other cost centers will bear their appropriate share of the costs of the Director's Office until all of the 4629 LE are reapportioned. To verify the mathematics of this phase of the operation one should add the monies reapportioned and determine that the total is equal to the total accumulated and total allocated expenses of the Director's Office, in this example 4629 LE.

The next step is to add the reapportioned cost to each cost center's total accumulated and total allocated expenses. In our example, the new total for the Administration Department is 36734 + 2315 = 39049 LE. All monies in the new total column must sum to the total laboratory budget as a check, in this example 266429 LE.

Reapportionment is completed when all nonrevenue cost center monies have been distributed to each revenue producing cost center. Table E shows an example of reapportionment of the Administration Department's staff effort. Table F shows an example of reapportionment of the Engineering Department's staff effort. The entire expense of operating the CPHL is now reflected in the revenue producing cost centers; the data is shown in the Final Total column.

E. Calculating an Estimate of a Cost Per Test

With the completion of the estimates of total costs of revenue producing cost centers where the tests are done, we are able to estimate the cost for each individual test, procedure, determination, assay, or related services provided by the laboratory. Total workload units produced by each cost center are taken from Table XVII in the main body of this report and placed in the appropriate column of Table C. No workload units exist for work done in the Licensure and Inspection cost center, so no estimate of cost per unit of work can be calculated. The other revenue producing cost centers do produce work measured in workload units.

Dividing the total cost of each cost center by the total workload units produced by that cost center one obtained a cost in Egyptian pounds per workload unit. As can be seen in Table C, using the data in our example, Microbiology's cost per workload unit is .05 LE, Clinical Pathology's is .13 LE, Sanitary Chemistry's is .02 LE, and Toxicology's cost estimate is .04 LE. The CPHL's average estimate is .04 LE, as seen on line 11.

To illustrate the calculation of an estimated cost per test, let us compute the cost of processing an enteric specimen. First, one must derive the total workload units involved. Tables G and H will be used in this example. Column 4, Table G, is the percentage of time enteric specimens are subjected to the procedures in column 1; i.e., all enteric cultures are subjected to a primary culture and to a secondary culture, with 50% of those (on the average) receiving a subculture. The adjusted workload value for a negative enteric specimen is obtained by multiplying column 3 by column 4. The resulting products, column 5, are then added to derive the total workload

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TABLE A

COST ESTIMATION
ACCUMULATION AND ALLOCATION - CPHL 1978 DATA

LINE	TYPE OF EXPENSE		COST CENTERS								
			DIRECTOR'S OFFICE	ADMINIS-TRATIVE DEPARTMENT	ENGINEER-ING DEPARTMENT	LICENSURE AND INSPECTION OF PRIVATE LABORATORIES	MICRO-BIOLOGY DEPARTMENT	CLINICAL PATHOLOGY DEPARTMENT	SANITARY CHEMISTRY DEPARTMENT	TOXICOLOGY DEPARTMENT	TOTAL EXPENSES
01	Accumulated Expenses		XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXX XXXXXXXX XXXXXXXX
02	Personnel (Salaries/Benefits/ Overhead)		3730	29840	16785	3730	63410	18650	42895	7460	186500
03	Supplies		100	500	2000	200	18500	6221	6222	6221	39964
04	Total Accumulated		3830	30340	18785	3930	81910	24871	49117	13681	226464
05	Allocated Expenses	BASIS	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXX XXXXXXXX XXXXXXXX
06	Other	PERCENT OF PERSONNEL	799	6394	3597	799	13588	3997	9192	1599	39965
07	Total Allocated		799	6394	3597	799	13588	3997	9192	1599	39965
08	Total Accumulated and Total Allocated		4629	36734	22382	4729	95498	28868	58309	15280	266429

TABLE B

CPHL 1978 DATA
ALLOCATION

TOTAL AMOUNT TO BE ALLOCATED 39965

Cost Center	Number of Personnel	Percent of Total	Allocated Amount
Director's Office	7	2	799
Administration Department	58	16	6394
Engineering Department	34	9	3597
Licensure and Inspection	6	2	799
Microbiology Department	122	34	13588
Clinical Department	37	10	3997
Sanitary Chemistry Department	85	23	9192
Toxicology Department	15	4	1599
TOTAL	364	100	39965

TABLE C

CPHL 1978 DATA - REAPPORTIONMENT

LINE	COST CENTERS	TOTAL ACCUMULATED AND TOTAL ALLOCATED EXPENSES	REAPPORTIONMENT									TOTAL WORKLOAD UNITS PRODUCED	COST PER WORKLOAD UNIT IN LE
			DIRECTOR'S OFFICE			ADMINISTRATION DEPT.			ENGINEERING DEPT.				
			Reapportioned Cost		New Total	Reapportioned Cost		New Total	Reapportioned Cost		Final Total		
			%	Monies		%	Monies		%	Monies			
01	Nonrevenue Cost Centers	XXXXXXXXXX XXXXXXXXXX	XXXX XXXX	XXXXXX XXXXXX	XXXXXX XXXXXX	XXXX XXXX	XXXXXX XXXXXX	XXXXXX XXXXXX	XXXX XXXX	XXXXXX XXXXXX	XXXXXXXX XXXXXXXX	XXXXXXXX XXXXXXXX	XXXXXXXX XXXXXXXX
02	Director's Office	4629	XXXX XXXX	XXXXXX XXXXXX	XXXXXX XXXXXX	XXXX XXXX	XXXXXX XXXXXX	XXXXXX XXXXXX	XXXX XXXX	XXXXXX XXXXXX	XXXXXXXX XXXXXXXX	XXXXXXXX XXXXXXXX	XXXXXXXX XXXXXXXX
03	Administration Department	36734	50	2315	39049	XXXX XXXX	XXXXXX XXXXXX	XXXXXX XXXXXX	XXXX XXXX	XXXXXX XXXXXX	XXXXXXXX XXXXXXXX	XXXXXXXX XXXXXXXX	XXXXXXXX XXXXXXXX
04	Engineering Department	22382	5	231	22613	10	3905	26518	XXXX XXXX	XXXXXX XXXXXX	XXXXXXXX XXXXXXXX	XXXXXXXX XXXXXXXX	XXXXXXXX XXXXXXXX
05	Revenue Cost Centers	XXXXXXXXXX XXXXXXXXXX	XXXX XXXX	XXXXXX XXXXXX	XXXXXX XXXXXX	XXXX XXXX	XXXXXX XXXXXX	XXXXXX XXXXXX	XXXX XXXX	XXXXXX XXXXXX	XXXXXXXX XXXXXXXX	XXXXXXXX XXXXXXXX	XXXXXXXX XXXXXXXX
06	Licensure and Inspection	4729	7.5	347	5076	4	1562	6638	20	5303	11941	XXXXXXXX XXXXXXXX	XXXXXXXX XXXXXXXX
07	Microbiology Department	95498	7.5	347	95845	30	11714	107559	20	5304	112863	2451100	.05
08	Clinical Pathology Department	28868	12.5	579	29447	18	7029	36476	20	5304	41780	322599	.13
09	Sanitary Chemistry Department	58309	10	463	58772	24	9372	68144	20	5304	73448	3428249	.02
10	Toxicology Department	15280	7.5	347	15627	14	5467	21094	20	5303	26397	678700	.04
11	TOTAL	266429	100	4629	266429	100	39049	266429	100	26518	266429	6880648	.04

TABLE D

CPHL 1978 DATA
REAPPORTIONMENT OF DIRECTOR'S OFFICE

DIRECTOR'S OFFICE STAFF	PERCENT OF TIME PROVIDED TO EACH COST CENTER							
	ADMIN. DEPT.	ENG. DEPT.	LIC. AND INSP.	MICRO. DEPT.	CLIN. PATH. DEPT.	SANI. CHEM. DEPT.	TOXI. DEPT.	TOTAL
Director	50	5	10	5	15	10	5	100
Administrators, Clerks and Workers	50	5	5	10	10	10	10	100
Total Percent of Service	100	10	15	15	25	20	15	200
Adjusted Percent of Service (Total ÷ 2)	50	5	7.5	7.5	12.5	10	7.5	100

TABLE E

CPHL 1978 DATA
REAPPORTIONMENT OF ADMINISTRATION DEPARTMENT

FUNCTIONS OF ADMINISTRATION DEPARTMENT	PERCENT OF SERVICES PROVIDED TO EACH COST CENTER						
	ENG. DEPT.	LIC. AND INSP.	MICRO. DEPT.	CLIN. PATH. DEPT.	SANI. CHEM. DEPT.	TOXI. DEPT.	TOTAL
Personnel	11	2	42	12	28	5	100
Budget and Finance	11	2	42	12	28	5	100
Stores	5	0	25	25	25	20	100
Security	19	5	19	19	19	19	100
Statistics	6	10	21	21	21	21	100
Total Percent of Service	52	19	149	89	121	70	500
Adjusted Percent of Service (Total ÷ 5)	10	4	30	18	24	14	100

TABLE F

CPHL 1978 DATA
REAPPORTIONMENT OF ENGINEERING DEPARTMENT

FUNCTIONS OF ENGINEERING DEPARTMENT	PERCENT OF SERVICES PROVIDED TO EACH COST CENTER					
	LIC. AND INSP.	MICRO. DEPT.	CLIN. PATH. DEPT.	SANI. CHEM. DEPT.	TOXI. DEPT.	TOTAL
Equipment Maintenance	0	25	25	25	25	100
Automotive	60	10	10	10	10	100
Drawing	0	25	25	25	25	100
Total Percent of Service	60	60	60	60	60	300
Adjusted Percent of Service (Total ÷ 3)	20	20	20	20	20	100

TABLE G

WORKLOAD UNITS PRODUCED IN
PROCESSING NEGATIVE ENTERIC SPECIMEN

(1)	(2)	(3)	(4)	(5)=(3)x(4)
Procedure	Batch Size	Workload Units	% of Time	Adjusted Workload Unit
Primary Culture	>100	3	100	3.0
Secondary Culture	>100	3	100	3.0
Subculture	11-100	2	50	1.0
ADJUSTED WORKLOAD UNITS FOR NEGATIVE ENTERIC SPECIMEN				7.0

TABLE H

WORKLOAD UNITS PRODUCED IN
PROCESSING POSITIVE ENTERIC SPECIMEN

(1)	(2)	(3)	(4)	(5)=(3)x(4)
Procedure	Batch Size	Workload Units	% of Time	Adjusted Workload Unit
Primary Culture	>100	3	100	3.0
Secondary Culture	>100	3	100	3.0
Subculture	11-100	2	50	1.0
Biochemicals	11-100	6	25	1.5
Agglutination Grouping	Single Sample	12	25	3.0
Complex Serotyping	Single Sample	45	10	4.5
ADJUSTED WORKLOAD UNITS FOR POSITIVE ENTERIC SPECIMEN				16.0

Preventive Maintenance System

GUIDE ON LABORATORY ADMINISTRATION

VIII MAINTENANCE

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INTRODUCTION

Maintenance of equipment is an extremely important function in government and industry. Manufacturing industries almost without exception schedule the inspection of equipment to prevent the majority of costly breakdowns and major repairs. Scheduled or preventive maintenance in public health laboratories, however, is largely neglected. A laboratory usually contains many instruments and much equipment, thereby making preventive maintenance an economically favorable concept to employ. The cost of inspections, lubrications, and adjustments of laboratory instruments and equipment appears insignificant when compared with the cost of emergency repairs and equipment rebuilding or overhauling.

Preventive maintenance (PM) may be defined as scheduled inspection resulting in minor adjustment or repair to delay or avoid major repair and emergency or premature replacement. The success of a preventive maintenance program rests on inspection and the related duties of adjustment and repair. Whether applied to precision laboratory equipment, giant manufacturing machines, or buildings and building systems, PM means planning ahead - scheduling certain inspection and maintenance functions that will prevent most breakdowns.

Benefits from preventive maintenance on laboratory instruments and equipment are outlined in this section [100] of the Maintenance chapter of the Guide on Laboratory Administration. Ideas on setting up a PM program with accompanying record cards on which to collect the data necessary to evaluate how well PM is working are also presented.

BENEFITS FROM PREVENTIVE MAINTENANCE

Preventive maintenance procedures in the laboratory prove to be more beneficial than maintenance programs which provide only for repairs of breakdowns and failures. With PM, repairs and adjustments can be made when it is convenient, instead of when a breakdown occurs.

The following are the major benefits of preventive maintenance over breakdown maintenance:

A. Greater Safety

Unexpected breakdowns or failures of certain laboratory equipment items can be particularly hazardous to the

health and safety of the operator. For example, should a biological safety cabinet fail while a worker is handling pathogenic materials, the effect can be serious. Periodic measurement of air-handling efficiency and inspection of other safety features during periods when such material is not being handled will often determine if the equipment is effective.

B. Less Employee Idle-time

PM inspections and the related repairs and adjustments to the equipment items should be performed when the item is not in use. In this way, workers can continue using the equipment without interruption. We have observed that if a piece of equipment breaks down while in use, the operator tends to avoid starting other projects until the item is repaired and he can complete the procedure that was in process. PM will not eliminate all breakdowns but should reduce them significantly.

C. Fewer Interruptions of Production

By reducing the number of unexpected equipment failures, important or critical research projects will not be interrupted, and specimen examination results will continue to be timely.

D. Better Product Quality

Periodic inspection and adjustment of precision equipment will help maintain the quality of biologics and reagents and the accuracy of examinations, measurements, and other determinations.

E. Lower Repair Costs

The minor repairs and adjustments associated with preventive maintenance should cost less than repairs for equipment breakdowns because less maintenance manpower, fewer skills, and fewer parts are needed for PM.

F. Elimination of Premature Replacement

Without periodic lubrications, adjustments, and occasional overhaul, equipment will wear out rapidly. Premature replacement of equipment results in unnecessary capital outlays which are often difficult to make from a budget standpoint even when justified.

G. Less Standby Equipment

Equipment that is expected to break down fewer times and less severely due to preventive maintenance should normally not require standby equipment. The capital investment for duplicate equipment items that are, for the most part, unused is considerable. In cases where it is critical that work not be interrupted, standby equipment may be necessary.

H. Identification of High Maintenance Costs

An advantage of a PM system and the accompanying records is identification of equipment items with high maintenance costs. Maintenance costs that appear high in relation to previous periods or to expected costs should lead to investigation and correction of causes such as (a) misapplication of the equipment, (b) operator abuse, (c) poor maintenance procedures, and (d) equipment obsolescence.

I. Better Spare Parts Control

Preventive maintenance calls for scheduled replacement of certain equipment parts and components. Planned replacements result in more timely ordering of spare parts.

Many of the preceding benefits of PM relate directly to reduction of capital investment and operating costs which are of great importance to the management of the laboratory.

HOW TO SET UP A PREVENTIVE MAINTENANCE PROGRAM

[redacted] Selling the PM Concept [redacted] The PM program must be sold, and should first be sold to higher management. Management's initial question may be something like "what will it save?" or "how much will it cost?" To answer this question:

a) Check the past year's records for equipment breakdowns, and list total cost of repairs on each item, including maintenance labor and parts. Also, include what each breakdown costs in employee idle-time, product spoilage and rework, and losses due to injury or illness.

b) Estimate cost of minor adjustments, repairs, and replaced parts if these actions could have prevented the breakdowns and estimate the personnel costs for scheduled inspections. (We must assume that the necessary adjustments, repairs, or replacements would have been detected through scheduled inspections.)

Analyses made from records and from reliable cost estimates stimulate the interest of management and become the real selling points for a sound preventive maintenance program. It should be pointed out that direct maintenance costs will probably rise at the outset. PM is an investment that needs extra cash; however, the return, in higher output, better quality, and lower capital investment is highly promising.

[redacted] What to Inspect [redacted] The first step to implementing the PM program is to create an equipment record card for each item of laboratory equipment -- that is, if such a card does not already exist. One example of an equipment record card is shown in Appendix I, page VIII-111. The card should provide space for information such as equipment manufacturer and vendor, equipment and motor description and specifications, location of equipment and changes in location, and lubrication and preventive maintenance check points. The equipment card should also provide for the recording of original equipment cost, installation costs, modification costs, yearly depreciation, annual maintenance costs, and a more detailed cost breakdown, including parts, labor, and overhead for each maintenance job whether performed under PM or breakdown conditions. Overhead is usually estimated at 10-15% of direct labor costs and includes such indirect costs as leave and nonproductive time for maintenance personnel and clerical and supervisory personnel supporting the maintenance function. Space for recording cost information can be provided on the back of the equipment record card, as illustrated in the example in Appendix I, page VIII-112. When each item of equipment is so described, an initial decision should be made as to the need for preventive maintenance inspections. The decision should be based on the benefits outlined previously. Ask yourself, "If this item of equipment fails or unexpectedly breaks down, will the health and safety of the workers be endangered? Will a critical project be interrupted or important production output be delayed? Will the cost of PM exceed expense of employee idle time and cost of repair or replacement?"

The element of cost should dominate the decision of what to include in the preventive maintenance program. Everything should not necessarily be included in the program. For example, one organization erected a building solely for housing special experiments calculated to run one year, and maintained it on that basis. Shortly after conclusion of the experiments, the building all but fell apart. Although the building had been severely under-maintained, it had served its purpose and the absence of preventive maintenance in this case was economically sound. Likewise, it might seem engineering folly to let a $500 motor go to ruin to keep a project going, but one must consider the possibility of greater loss in work-in-progress or failure to provide timely results because of an equipment shutdown for preventive maintenance.

The question of "what to inspect" must be extended from equipment items to parts or components of each item. One of the best sources for this information is the service manual issued by the manufacturer.

It is an invaluable guide on what to inspect and how often, as well as how to install, service and maintain the equipment. These manuals should be filed; if they cannot be found for some of your existing equipment items, you can obtain them from local vendors or the manufacturer's headquarters. The equipment user, who may regularly maintain the equipment, can often pinpoint an item likely to wear or get out of adjustment under local conditions that even the manufacturer might overlook.

Equipment manufacturers are helpful timetable sources for the frequency of inspections but they are careful to qualify their recommendations subject to normal conditions. One piece of equipment may have several frequencies for servicing, such as once daily for cleaning, once weekly for adjustment, once monthly for functional inspections, and once yearly for overhaul. Generally follow manufacturer's recommendations until you have good reason to alter them. Some recommended check points and frequencies of inspection for eleven equipment items commonly found in the laboratory are shown in Appendix II, page VIII-113. A series of articles on repair and maintenance of laboratory instruments appeared in the Bulletin of Pathology of the American Society of Clinical Pathologists during 1968.[2] Performance, precision, and price of such instruments as a robot chemist, UV photometer, osmometer, micropipetting system, and atomic absorption spectrophotometer are covered as well as a summary of the service policy and other maintenance hints. In the June 1970 issue of Laboratory Management, a composite of PM guidelines derived from thirteen manufacturers' recommendations is presented, including check points and frequencies for centrifuges, colorimeters, flame photometers, pH meters, and spectrophotometers.[3]

You must check results of preventive maintenance and be willing to modify inspection cycles. Replacing parts that can still deliver good service indicates that you are playing it too safe. To insure a continuing attack on the validity of frequency cycles:

a) Check new equipment more frequently until a breakdown occurs. In one case a new compressor was checked every day, then every week, and finally once every four months.[4]

b) Whenever a unit is inspected or repaired, require inspectors to indicate on inspection reports whether frequency cycles need a boost or a cut.

Who Should Inspect A preventive maintenance inspector should be a craftsman with top skills who has the ability to test, adjust, and repair the unit he inspects. A person who oils or lubricates equipment cannot always diagnose trouble. During actual inspections, extensive repairs should be avoided and only minor adjustments should be made. If the size of the PM program is such that several maintenance personnel are involved, the servicemen should be rotated frequently to assure

thorough and complete inspections. In this way, a defect overlooked on one inspection may be caught by a serviceman with a fresh viewpoint. Also, because the inspector has not performed the previous inspection, he is more likely to be impartial.

Many smaller laboratories will not be able to justify a full-time equipment maintenance position. Repair services may be available from a higher organizational level, but if not, PM inspections may have to be provided from within. In such cases an employee who has a propensity for repairing and adjusting equipment can be instructed in basic PM procedures and this responsibility added to his job description. This will often result in an upgrading for the individual.

PM is not strictly a maintenance responsibility. It is everybody's job. Equipment users and all employees coming into contact with equipment should be encouraged to report conditions that appear unusual; for example, strange equipment noises or vibrations, leaks, and frayed wires or cords.

Not all organizations are blessed with a maintenance staff that can handle any type of equipment malfunction. Manufacturer's servicemen may at times be called in for certain repairs. In fact, company service representatives should maintain certain highly complex and delicate items, including the scheduled inspections. Most equipment manufacturers offer maintenance contracts which usually include scheduled preventive maintenance.

A difficult question to resolve is whether to accept a maintenance contract or not. In deciding on a service contract, consider availability and competence of in-house maintenance personnel, possible difference in quality and timeliness of service and availability of parts by the manufacturer when maintenance is performed with and without a contract, and expenses such as equipment overhaul or parts replacement when a service contract is signed after the required date or when it is cancelled and then renewed. A well-trained, in-house maintenance staff providing effective preventive maintenance can result in minimum equipment breakdowns so that the few service calls that might be necessary could be most economically performed on a noncontract basis.

■ The Maintenance Job-Request ■ The equipment record card which contains information about whether or not an item requires preventive maintenance as well as what and when to inspect, is usually filed by equipment name. Duplicate record cards can be filed by date of the next scheduled PM inspection. At the beginning of a work week, cards representing those items requiring inspection can be further arranged and the best day and time of day for inspection can be determined. A clerk or secretary can initiate a scheduled maintenance job-request when an inspection is due. Such a form might include equipment identification and location information; inspection check points and frequencies followed by spaces to record condition of the equipment; date of inspection and amount of time

for inspection and repair; costs of maintenance labor, parts, and employee idle-time, if any; and pertinent remarks on changes in inspection points, frequency, or anticipated repairs or replacement. The PM checklist would not include every detail that the serviceman should inspect. To avoid discouraging his ability or imagination, space should be provided for extra comments such as description of the malfunction and the necessary repairs. An example of a scheduled maintenance job request is shown in Appendix III on page VIII-119.

Requests to repair equipment breakdowns and failures should also be initiated by a written job-order. An example of this type of form is shown on page VIII-120 as part of Appendix III. The form shows date work was requested, requestor, completion date required, reason for the request, action taken, and costs in maintenance labor, parts, and any employee idle-time.

The equipment record card, including the cost record portion on the back, and the scheduled and unscheduled maintenance job-orders are probably the minimum of record cards and forms necessary to collect complete data to evaluate the PM system. The examples shown in the Appendices are a representation of many such forms in use. In general, there is a choice between manual systems and business machine operations. A manual system can give just as much data and selectivity as a mechanized system and is best suited where PM is on a limited scale. When a great many equipment items are in the PM system and the combinations and permutations of inspection points and frequencies are great, a mechanical punched-card system is desirable. Some systems combine elements of both manual and mechanical operation. Some of the leading manufacturers of forms and equipment that have been used in industrial preventive maintenance programs are shown in Appendix IV on page VIII-121. These companies and others can furnish exhibits of many types of applications and aid in the design or selection of appropriate forms and records. No PM system, however simple, should be installed without a flow study which shows the route of every form and what records and reports are generated by each form.

EVALUATING THE PM SYSTEM

How do you know if you are over-maintaining, under-maintaining, or providing just the right amount of preventive maintenance? If cost records indicate unscheduled (breakdown) maintenance greatly exceeding PM costs, then PM inspections may occur too infrequently, PM procedures are not being satisfactorily performed, or maintenance personnel are not effectively repairing or getting to the source of equipment breakdowns. On the other hand, if no equipment breakdowns or failures occur, the extent of the PM provided may be more than is necessary. What is considered a reasonable ratio of preventive maintenance to breakdown maintenance? One

source from industry advises that 80-90% of total maintenance manhours should be devoted to scheduled work, including repairs resulting from PM inspections.[4] Another source believes that 50 to 75% of maintenance tasks should be of preventive nature.[5]

Using one of these ranges, or selecting a plausible average, you can analyze the cost data accumulated on the equipment record cards. Comparing maintenance cost data for a year may lead to one or more of the following decisions:

- No change in the current PM frequency or inspection points
- An increase in frequency of PM inspection or addition of inspection points
- A decrease in frequency of PM inspection or elimination of some inspection points
- Discontinuance of scheduled PM on certain items of equipment thereby performing breakdown or emergency maintenance only and providing standby or rental equipment if necessary
- Modification, overhaul, or rebuilding of equipment due to mounting costs of preventive and breakdown maintenance
- Replacement of equipment when average annual maintenance costs exceed the book or scrap value of the equipment

The most appropriate decision can be reached through the cost-benefits analysis technique when expenditures in one or more work functions have a causative relationship with the expenditures for related work functions. This relationship certainly exists between scheduled PM and breakdown maintenance.

Replacing an item of equipment on a timely basis is important to management - cost wise and for planning purposes. A simple replacement analysis technique can be applied for use in both long and short term equipment replacement planning.[6]

First, compute an annual allowance for depreciation using the following formula:

$$D = \frac{C - S}{N}$$

where D = annual depreciation allowance

C = initial cost of equipment, including installation

S = estimated salvage value at the end of the equipment service life

N = number of years of estimated equipment service life or useful life, considering obsolescense

Then compute the depreciated value (D.V.) of the equipment for any particular year. For example, the D.V. after one year can be seen as

$$D.V._1 = C - D$$

The depreciated value after two years of equipment life is

$$D.V._2 = D.V._1 - D$$

and after three years is

$$D.V._3 = D.V._2 - D$$

and so on through the remaining years of equipment life.

Next, total the annual functional costs, which consist of scheduled preventive maintenance, breakdown and emergency maintenance, and equipment modification, overhaul and rebuilding. This relationship of functional costs to the depreciated value is illustrated in Figure 1, Equipment Replacement.

The equipment replacement graph shows an item of equipment that originally cost $3,000 and has an estimated life of 10 years and no salvage value. The annual depreciation allowance, therefore, is $3000-0/10 or $300. The depreciated value after one year is $3000-$300 or $2,700, after two years is $2,700-$300 or $2,400 and so on. When the functional cost for a particular year approaches and exceeds the depreciated value of the equipment, consider replacement. At the same time, also consider new equipment and installation costs, possible gain in operating efficiencies, and decrease in maintenance costs.

EQUIPMENT REPLACEMENT

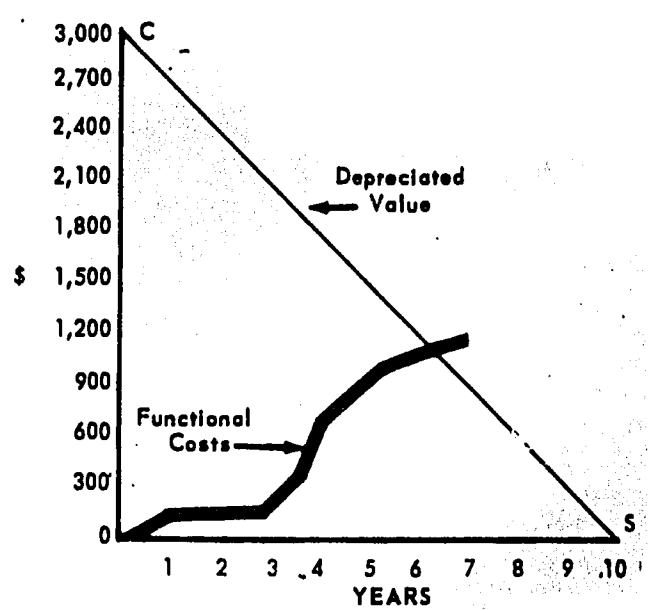

FIGURE 1

Another equipment replacement technique is described by Philip A. Scheuble, Jr., in the Harvard Business Review.[7] He uses eight yardsticks to arrive at a replacement decision: operating cost savings afforded by making the replacement, service life, repair costs, overhaul point, capital invested, salvage value, priority of replacement, and effect of taxes.

EQUIPMENT RECORD

DESCRIPTION	MAKER	SERIAL NO.	OUR NO.
UV Centrifuge		XYZ 101	001

VENDOR

ADDRESS

Date	Width	Weight	Water
Ordered 2-20-65 Received 3-15-65 Installed 3-20-65	29" Depth 24" Height 50"	365 lbs. Exhaust Air	Gas Steam

DETAILS Speeds between 1200 & 5600 r.p.m. producing relative centrifugal forces between 300-5100 x G

Location: Now in Dept.	Transfers: Date	To	Date	To	Date	To
Bacteriology Room 127						

Lubrication Points & Recommended Frequency

Initially & every 4 mos. remove head and dust cover; add lube so grease cup is kept full. Once yearly remove and replace grease.

Preventive Maintenance (P.M.) Inspection Points & Frequency

Check brushes quarterly & replace if worn to 5/16".
Check autotransformer carbon brush quarterly; replace if less than 1/16" is protruding.

Motor Record

Maker	HP	RPM	Type	Frame	Style	Serial No.	Model No.	Volts	Amps	Watts
	1.0							120		440

Phase	Cycle	Control Equipment	Drives	Belts	Type Bearing	Data	Our No.

For Illustrative Purposes Only
DHEW, PHS, HSMHA, CDC

4C703487I

EQUIPMENT COST RECORD

ORIGINAL COST	INSTALLATION COST	TOTAL COST	MODIFICATION &/OR REBUILD	DEPRECIATION FOR 10 YEARS
$ 2,100.00	$ —	$ 2,100.00	$ — (DATE)	@ $ 210.00 per year

ANNUAL MAINTENANCE COST	19 65	19 66	19__	19__	19__	19__	19__	19__
	$ 200.00 Serv. Contract	$ 146.85	$	$	$	$	$	$

DATE	WORK ORDER NUMBER	TYPE OF MAINTENANCE		PART-FAILURE CODE				COSTS					
		Sched. P.M.	Non-Scheduled	Sub-Assembly	Part	Cause	Action	PARTS & MATERIALS	LABOR	EMPL'EE IDLE-TIME	OVER-HEAD	TOTAL COST	ACCUM-ULATED COST
3-26-67	UM1501		✓	40	23	01	02	$8.15	26.50	10.00	2.65	47.30	47.30
4-1-67	PM 121	✓		—	—	—	—	—	15.50	—	1.55	17.05	64.35
7-3-67	PM 180	✓		61	15	11	02	5.00	23.00	—	2.30	30.30	94.65

KEY FOR PART-FAILURE CODE

Sub-Assemblies

01 Apron
02 Arm assembly
03 Air control
04 Base
05 Battery
06 Brake
07 Bridge
08 Brazer
09 Bed
10 Breaker
11 Boom
12 Carriage
13 Clutch
14 Controller
15 Column
16 Coolant System
17 Cross rail
18 Cross slide
19 Crank shaft
20 Cylinder
21 Distributor
22 Drive
23 Drum
24 Electrical alarm
25 Electrode
26 Fan
27 Face plate
28 Feed box
29 Feed mechanism
30 Frame
31 Furnace — oven
32 Generator
33 Head
34 Housing
35 Hoist
36 Knee
37 Light fixture
38 Magnets
39 Meter
40 Motor
41 Pump
42 Push button
43 Ram
44 Rectox
45 Recorder & Controls
46 Regulator
47 Relay
48 Rheostat
49 Rolls
50 Saddle
51 Spindle
52 Starter
53 Steering mechanism
54 Stock feed
55 Support (out post)
56 Switch
57 Switch — limit
58 Table
59 Tanks
60 Tail Stock
61 Transformer
62 Timer
63 Tap changer
64 Trolley
65 Truck
66 Turrent
67 Unreelers
68 Valve
69 Welder
70 Others

Parts

01 Adjusting screw
02 Arc shield
03 Arm
04 Armature
05 Band
06 Beam
07 Bearing
08 Bells
09 Belt
10 Blades
11 Bracket
12 Bucket
13 Bumpor
14 Bushing
15 Brushes
16 Brush holder
17 Ballast
18 Battery solution
19 Carbon
20 Cell
21 Clock motor
22 Collector
23 Commutator
24 Compartment
25 Conduit
26 Connectors
27 Contacts
28 Coils
29 Cable
30 Cam
31 Cam shaft
32 Chain
33 Chutes
34 Clamp
35 Clapper
36 Connecting rod
37 Coupling
38 Cups
39 Crank shaft
40 Diaphragm
41 Disc
42 Dog
43 Drive shaft
44 Electrode
45 Fan
46 Filter
47 Finger
48 Fittings
49 Fluid
50 Forks
51 Fuse
52 Gasket
53 Gear
54 Gib
55 Guide
56 Guard
57 Guage
58 Handle
59 Heater element
60 Hook
61 Hoppers
62 Hose
63 Horn
64 Impeller
65 Insulator
66 Insulation
67 Lamp
68 Leads
69 Lever
70 Line shaft
71 Lining
72 Link
73 Mast
74 Nut
75 Nozzle
76 Oil
77 Plates
78 Plunger
79 Plug
80 Packing
81 Pedal
82 Pins
83 Pintle
84 Piping
85 Piston
86 Platforms
87 Pulley
88 Rack
89 Ram
90 Retainer
91 Rings
92 Rolls
93 Rotor
94 Screw
95 Shunt
96 Solenoid
97 Socket
98 Spring
99 Shaft
100 Sheaves
101 Shifter
102 Slide
103 Sleeve
104 Screw-lead-feed
105 Strainer
106 Terminals
107 Thermocouple
108 Thermostat
109 Tongs
110 Tube
111 Tires
112 Toggle
113 Tubing
114 Valve
115 Ways
116 Wheel
117 Wire or cable
118 Worm
119 Complete Unit
120 Others

Cause for Repair

01 Dirt — Oil — Moisture
02 Fatigue
03 Incorrect setup
04 Incorrect lubrication
05 Improper setting
06 Improper use
07 Installation
08 Lack of lubrication
09 Misalignment
10 Modify
11 Normal wear
12 Over heating
13 Overload
14 Out of balance
15 Shorted
16 Wrong material

Action Taken

01 Repair
02 Replace
03 Modify
04 Rebuild

For Illustrative Purposes Only
DHEW, PHS, HSMHA, CDC

APPENDIX II

Recommended Preventive Maintenance (PM) Check Points and Frequencies of Inspection for Eleven Laboratory Equipment Items.

ITEM OF EQUIPMENT	PM INSPECTION POINTS AND ACTION REQUIRED	FREQUENCY OF PM
Centrifuge	Lubricate bearings (if not permanently lubricated and sealed).	Quarterly
	Remove head and dust cover and add lubricant so grease cup is kept full.	Quarterly
	Check commutator for scratches, grooves, or dirt and use fine sandpaper (0 or 00) if roughened.	Quarterly
	Check brushes and replace if worn to 5/16".	Quarterly
	Check autotransformer carbon brush and replace if less than 1/16" is protruding.	Quarterly
	Wash chamber and cover gasket and check for wear or cracks in gasket.	Quarterly
	For refrigerated centrifuges, listen for noisy condenser; clean condenser coils of dust and lint and vacuum or dry brush condenser fins	Semi-annually
	Check oil level in reservoir.	Semi-annually
	Check rotor nut and shaft threads	Semi-annually
	Replace grease in grease cup	Annually

ITEM OF EQUIPMENT	PM INSPECTION POINTS AND ACTION REQUIRED	FREQUENCY OF P.M.
Sterilizer (and Autoclave)	Check valves & fittings for leaks and check door gasket for leaks, hardening, and cracking.	Monthly
	Clean steam traps and strainers and check for leaks and restrictions	Monthly
	Check operation of steam safety valve, gages, instruments, lights, timers, recorders	Monthly
	Spray door gaskets with silicone	Semi-annually
	Lubricate drive motors if equipped	Semi-annually
	Lubricate door hinges and locking devices.	Semi-annually
Refrigerator and Freezer	Check door hinges and latch for tightness and free operation	Monthly
	Check door gasket for cracks, deterioration, and security of attachment	Monthly
	Check operation of pilot and interior lights	Monthly
	Check evaporator and condensate drain.	Monthly
	Check for frost buildup and defroster operation.	Monthly
	Check compressor for leaks, corrosion, and proper operation.	Monthly
	Check belt tension and oil level on unsealed units.	Monthly

ITEM OF EQUIPMENT	P.M. INSPECTION POINTS AND ACTION REQUIRED	FREQUENCY OF P.M.
Refrigerator and Freezer (cont'd.)	Lubricate door hinges and lock.	Semi-annually
	Clean compressor unit and condenser coils	Semi-annually
Incubator	Check operation of all indicator lights and switches	Bi-weekly
	Check for carbon dioxide leaks	Bi-weekly
	Adjust door gaskets if loose; replace if cracked	Quarterly
	Check thermostat against accurate thermometer.	Quarterly
	For egg incubators, check humidity and motor and timer setting for egg turn	Quarterly
Lyophilizer	Check V-belts for wear, tension, and alignment	Monthly
	Check hardware and mounting bolts for tightness.	Monthly
	Check oil level in vacuum pump and compressor and check for moisture in oil.	Monthly
	Check valve operation and packing.	Monthly
	Check door gasket condition and check unit for leaks.	Monthly
Oven	Adjust door gaskets if loose; replace if cracked	Semi-annually
	Clean visible heating elements	Semi-annually

ITEM OF EQUIPMENT	P.M. INSPECTION POINTS AND ACTION REQUIRED	FREQUENCY OF P.M.
Oven (cont'd.)	Check cord and plug for brittleness.	Semi-annually
	Check thermostat against accurate thermometer.	Semi-annually
pH Meter	Check electrode for loss of sensitivity and change glass or calomel electrode as needed.	Weekly
	Rinse electrodes used for blood pH with saline, then water	Weekly
	Check input tube, mechanical zero (whenever moved), and water bath	Quarterly
	Clean switch assembly contacts	Annually
Spectrophotometer	Check bulbs for dirt or dust and wipe clean with a cloth	Bi-weekly
	Readjust Xenon lamps	Bi-weekly
	Clean, rinse, and dry cuvettes	Bi-weekly
	Wipe clean exit and collimating mirrors or wash with alcohol and distilled water and drain dry.	Bi-weekly
Flame Photometer	Disassemble and clean manifold or compressor air filter	Monthly
	Clean element from air compressor intake muffler	Quarterly
	Replace air filters that cannot be cleaned	Semi-annually

ITEM OF EQUIPMENT	P.M. INSPECTION POINTS AND ACTION REQUIRED	FREQUENCY OF P.M.
Flame Photometer (cont'd.)	Remove and clean chimney.	Semi-annually
	Check and clean cooling system.	Annually
	Replace cleanable air filters	Annually
	Immediately clean dirt from atomizer bowl	When visibly dirty
	Clean burner head and ignition block of encrusted salts.	When salts form
Colorimeter	Wash out entire system.	Daily
	Check alignment and cleanliness of flow cells	Daily
	Check cuvettes and clean or discard marred sample holders.	Daily
	Check flow cell connections for leaks	Weekly
	Check filters and clean with lens paper if necessary, and wipe apertures free of dust with damp cloth	Weekly
	Remove colorimeter cover and inspect for spillage	Weekly
	Inspect and clean lamp	Monthly
	Clean entire optical system, including lenses	Quarterly
	Check flow cell tubing and replace if needed	Quarterly

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Equipment manuals from Precision Scientific Co. and International Equipment Co

SCHEDULED PREVENTIVE MAINTENANCE ORDER AND CHECK LIST

P.M. SCHEDULE	EQUIPMENT ITEM	EQUIP. SERIAL NO.	OUR NUMBER	EQUIP. LOCATION
Quarterly, Annual	UV centrifuge	XYZ 101	001	Bact. 127

INSP. FREQUENCY:
- W — Weekly
- M — Monthly
- Q — Quarterly
- S — Semi-Ann.
- A — Annually
- B — Bi-Ann.

Inspection Date Mo.	Day	Year	SCHEDULED MAINTENANCE CHECK LIST: Lubricate Head (Q)	Lube dust cover (Q)	Remove to 5/16" (Q)	Auto Brush to 1/4" (Q)	Replace grease (A)			General Conditions	P.M. Inspector's Number or Initials	INSPECTION HOURS: Labor	Travel	COSTS: Labor and Travel	Parts and Materials	Employee & Production Downtime	REMARKS
4	1	67	✓	✓	✓	✓				G	L.J.R.	2	1/2	15.50	—	—	
7	3	67	✓	✓	✓	24					B.S.E.	3	1/2	23.00	5.00	—	Replaced auto brush

✓ = OK

1. Bent	6. Broken	11. Distorted	16. Lubrication	21. Seepage	26.	General Condition
2. Blister	7. Chipped	12. Dry	17. Misalign	22. Soft	27.	
3. Blown Out	8. Corrosion	13. Fractures	18. Missing	23. Weak	28.	G — Good
4. Burn Out	9. Debris	14. Frayed	19. Plugged	24. Worn	29.	F — Fair
5. Burned	10. Dirt	15. Loose	20. Scored	25.	30.	P — Poor

For Illustrative Purposes Only
DHEW, PHS, HSMHA, CDC

NON-SCHEDULED MAINTENANCE ORDER

DATE REQUESTED	REQUESTED BY	FROM, DEPT.	JOB REQUIRED BY	EMERGENCY	AUTHORIZED BY
3-25-67	Dr. Rogers	Bact.	Date: A.S.A.P.	yes	Dr. J.R. Smith

EQUIPMENT DESCRIPTION	OUR NO.	SERIAL NO.	LOCATION
UV Centrifuge	001	XYZ101	Bact. Room 127

Problem and/or Work Requested

Motor will not start

Action Taken, including parts or materials used; General Condition; and Recommendations for Future Upkeep or Preventive Maintenance (P.M.)

Commutator was badly roughened from dirt and oil and had to be replaced. I recommend more frequent PM as centrifuge is getting more than normal usage.

WORK ORDER NO.	REPAIRMAN	DATE COMPLETED	HOURS		COSTS			ACCEPTED BY	DATE CLOSED
			LABOR	TRAVEL	LABOR & TRAVEL	PARTS & MATERIALS	IDLE-TIME		
UM1501	S. Allen	3-26-67	3	1/2	26.50	8.15	10.00	Mrs. Fox	3-26-67

For Illustrative Purposes Only
DHEW, PHS, HSMHA, CDC

APPENDIX IV

Some Manufacturers* of Forms and Equipment That Have Been Used in Industrial Preventive Maintenance Programs

Acme Visible Records, Inc., 8900 W. Allview Dr., Crozet, Virginia 22932 (Visible Record Equipment and Information Retrieval Systems)

Addressograph-Multigraph Corp., 1251 Bobbitt Rd., Cleveland, Ohio 44132

IBM Corp., Old Orchard Rd., Armonk, New York 10504

McBee Litton Automated Business Systems, 80 Greenwich Ave., P.O. Box 1189, Greenwich, Connecticut 06380

Sperry Rand Corp., Remington Office Equipment Division, 1290 Ave. of Americas, New York, New York 10019 (Electromechanical filing systems; visible records systems)

Visirecard, Inc., Railroad Ave., Copiague, L.I., New York 11726 (Visible Vertical Record-Keeping Equipment; Accounting Forms)

Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the Department of Health, Education, and Welfare.

*The Company's headquarters address is shown; local representatives may be contacted if available.

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TOPICS IN MANAGEMENT/INSTRUMENTATION

A Manual System for Storage and Inventory Control of Laboratory Supplies

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A Manual System for Storage and Inventory Control of Laboratory Supplies

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The demand for laboratory supplies has increased in relation to the increase in the quantity and complexity of the laboratory workload. This has created many problems for the laboratory administration and a major one has been the lack of a good system for storage and inventory control of supplies. This paper presents a manual system for such control and suggests the use of two different control procedures.

In the operation of the laboratory, purchasing supplies of the proper quality and quantity at minimum price and having them available when needed are critical factors.

During the past several years, laboratory workloads have grown in quantity and complexity,[1,3,4] and the demand for supplies has increased accordingly. This demand has generated certain problems for the laboratory administration. For example, storage space for the increasing numbers and quantities of line items is limited. Procurement schedules, low bid procedures, and the possibility of obtaining quantity discounts may foster "overbuying" which can result in obsolescence and deterioration problems as well as overcrowding of the limited storage space. Some supply items may be "underbought," and thus may not be available during periods of unusually heavy workload. Another critical problem is the lack of a procedure to use in determining when supplies should be replenished and in what quantity, and in determining costs of supplies for budget and accounting purposes.

ACTIVITIES OF A SYSTEM FOR STORAGE AND INVENTORY CONTROL

An overall system includes the activities of ordering, procuring, receiving, storing, and issuing supplies and materials. The procuring or purchasing activity, although an integral part of the system, is often operated as an independent administrative entity within the laboratory scientific services function because it serves as the procuring activity for items other than supplies and materials. These items may be scientific equipment and instrumentation, office furniture and equipment, or preventive maintenance and housekeeping contracts. The discussion of the overall system presented here will be chiefly concerned with the remainder of the activities—ordering, receiving, storing, and issuing.

NEED FOR SYSTEM

The basic rationale for a system of storage and inventory control of supplies and materials is the need for *control.*

The nature and extent of control that must be built into the system depend upon several factors:

1. Reliability and timeliness required in providing items needed by laboratory personnel.
2. Level of dollar expenditure where closer control will yield greater efficiency.
3. Criticality of items for laboratory operation.
4. Spoilage, deterioration, obsolescence, pilferage, or need for special handling of certain items.
5. Availability of storage space.

In an industrial application, factor 2 would be considered most important in determining the extent of control. In a laboratory, factors 1 and 3 should receive the greatest emphasis because of the need to respond quickly in support of immediate medical diagnosis, to confirm a medical diagnosis, or to provide information required for implementation of epidemiological control measures. The best system for control is developed by giving the proper weight and consideration to all of the factors listed.

INVENTORY CONTROL PROCEDURES

The principal control mechanism for the supply activities of ordering, receiving, storing, and issuing is the inventory control procedure. This procedure involves records control as well as storage control of inventory. It can be operated and maintained by a manual system, by Electronic Data Processing (EDP), or a combination of both. In most laboratory organizations, a manually operated procedure should suffice. However, experience gained from this procedure can be used in designing and implementing an EDP procedure when it becomes feasible to do so. In this discussion, emphasis will be placed on the use of a manual procedure.

Generally, there are two types of procedures used in the control of inventories: the perpetual inventory control procedure and the periodic inventory control procedure. The

MISSING PAGE

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been categorized, a program of simplification and standardization should be instigated in order to *reduce* the varieties and types of items in inventory and set standards for fixed sizes, types, qualities, measures, flow speeds, and other measurable variables. (This program will not only serve to reduce the overall inventory, but will reduce handling of items, maintenance of stock records, space requirements, labor costs, procurement costs, and overall cost of inventory on hand. The use of simplification and standardization practices in the laboratory is explained elsewhere.)[5]

C. All stock items to be included in each category should be identified by nomenclature and specifications (name of item, size or specification, special use of item, if necessary, and other pertinent data). The stock number of each item is completed by assigning a three- or four-digit number, depending on the number of items in the category. An example for a particular pipette would be the following:

Nomenclature:

Pipette, 1 ml graduated to tip, graduated in 1/100.

Stock Number:

The first two digits of the stock number would be 10, for glassware. If items are listed by stock number in consecutive order, the particular number for this pipette could be 10599 or 105990, depending on the number of items in the 10 category. Separate stock numbers should not be set aside for each vendor supplying identical or nearly identical items unless there is some special or limited use of the item from one particular vendor or some slight difference in size or specification.

The stock number serves a dual purpose. First, it can identify a particular stock item being ordered from the stockroom by laboratory personnel, thus keeping requisitioning paper work at a minimum. Second, when an EDP application becomes feasible, it can serve as the key in retrieval and identification of all stock transactions and control of inventory.

D. Stock records should be set up for inventory control and storage locations. A suggested form is shown in Figure 1. This 5″ × 8″ form is designed for use in the Kardex® type of equipment, and suitable equipment should be procured before the system is actually implemented. Furthermore, the form should be printed on both sides of the paper, which doubles its utility for recording transactions and making available certain data required in the system for determining such things as *when* and *how much* to buy. In essence, the form is a decision-making tool, and its proper use is necessary for a system of storage and inventory control to be effective. Each section of the form is explained below:

1. **Stock Number.** Five- or six-digit number previously described.
2. **Stock Item Description.** This should include the nomenclature and item specifications, for example, pipette, 1 ml graduated to tip, graduated in 1/100.

Because of the permanency of the data and its visual position in the file, the above two sections should be filled in by typewriter. The remaining sections of the form should be filled in with pen or pencil, especially those sections where changes will be necessary from time to time.

3. **Unit of Issue.** A designator representing that quantity considered most convenient or economical to issue; for example, Each, Pound, Box, Gross, Can, 10/Can, Carton, Basket, Ounce, etc.
4. **Location.** A code showing the exact storage location of the stock item is placed in this section. For example, an item stored in the primary storage area in Storage Room A, Section 15, Row D would be shown as A15D. This system will be discussed further under heading H, entitled "Initiate storage control procedures."
5. **Vendors.** The initials or abbreviation of the name of the principal vendor(s) is recorded in this section. This information is useful if an emergency purchase is necessary.
6. **Transaction Sections** (vertical columns).
   a. Item Reference.
      (1) Date—The date of each transaction is recorded in this column.
      (2) Doc.—The number of the Purchase Request, Purchase Order, or other document is entered in this space.
   b. Ordered. Quantity ordered on above document is written here.
   c. Received. Quantity received of that ordered is recorded. **Note:** Quantities received may vary if an agreement has been made with the vendor for periodic or "drop-shipments." Then, two or more entries will be necessary to reconcile the receipts with the original quantity ordered.
   d. Cost. The cost per Unit of Issue is entered. For example, if 50 boxes of 12 ea/box of pipettes were received at a cost of $100.00 and the Unit of Issue is "Box," the entry will be $2.00. This cost can be entered on the individual laboratory requisition form for test costing purposes when items are issued.
   e. Issued.
      (1) Org.—The laboratory cost center to which the item(s) is issued is recorded. This record then can be used for assigning supply costs to the different cost centers and ultimately to the tests.
      (2) Quan.—The quantity issued to each cost center is recorded. Then if com-

FIGURE 1: STOCK RECORD FORM

Item Reference		Ordered	Received	Cost	Issued		Bal.	Item Reference		Ordered	Received	Cost	Issued		Bal.
Date	Doc.	Quan.	Quan.	Unit	Org.	Quan.	Quan.	Date	Doc.	Quan.	Quan.	Unit	Org.	Quan.	Quan.
9-2					G	50	270								
9-5	1205	1000													
10-20					F	25	245								
11-10	1205		1000	2.00			1245								
11-20					G	70	1175								
11-27					M	25	1150								
12-10					F	50	1100								
1-5				*	"I"		1050								
1-10					G	50	1000								

Order Point	Maximum	Monthly Usage Rate	Unit of Issue	Vendors
250	1100	80	Box (12)	SP, CG

Stock Number	Stock Item Description	Location
10980	Pipette, 1 ml Disposable	A-15-C

Perforate

(Remove After Typing)

*Inventory Reconciliation. Items issued but transaction probably not recorded.

mon-use supplies are in short supply, centers having adequate quantities on hand can be identified, and supplies can be reallocated accordingly.

f. Balance. Quantity on hand after each transaction is entered.

7. Monthly Usage Rate. This information is calculated from data obtained from the transaction sections discussed above. This computation is necessary for use in deriving the Order Point which will be discussed below. An example of computing the monthly usage rate is:

Month	Consumption
Jan	300
Feb	600
Mar	500
Apr	600
May	510
June	600
July	300
Aug	600
Sept	500
Oct	600
Nov	510
Dec	600
Total	6,220

Annual Usage = 6,220

Monthly Usage Rate (MUR) = $\frac{6,220}{12} = 518$

(Use 500 if safety stock is adequate—see discussion regarding Order Point.)

Note that the monthly usage varies widely because of special projects, epidemics, or normal seasonal workload fluctuation. Therefore, data for as many months as possible should be used in computing the monthly usage rate.

g. Order Point. Order Point is established in terms of units of issue on the basis of the number of units needed for issuance during procurement lead time, plus a safety stock

allowance. An Order Point would be computed as follows:

OP=(LT × MUR) + SS

where:

OP=Order Point

LT=Lead Time in months (from purchase until vendor delivers)

MUR=Monthly Usage (determined from monthly consumption data in Stock Ledger)

SS=Safety Stock (This quantity is reserved for use if lead times vary because of selection of a new vendor, varying procurement practices, and possibility of special projects, epidemics, or seasonal workload fluctuations. Safety Stock quantities are usually in 1 month quantities.)

An example of computation would be

LT=3 months

MUR=50

SS=50

OP=3(50)+50

OP=200

All stock items in the systems may not require use of the Order Point because of:

1) lack of criticality and low costs
2) ease of procurement
3) small amount of use
4) buying in maximum quantities because of local procurement policy or quantity discount
5) use of a periodic inventory control procedure for certain stock items as previously explained

8. **Maximum.** The maximum quantity to be procured is computed here. This quantity usually will be in accordance with local procurement policies for buying in quantities on a quarterly, semiannual, or annual basis, availability of primary and secondary storage space, spoilage, deterioration, breakage, obsolescence, and other factors. The maximum order under an annual procurement cycle could be (MUR×12)+SS. Written entries are made in Figure 1 to show how data are recorded in each of the sections described above.

E. All items should be placed in a stock catalog by category so that personne. requesting items through the supply system can identify them easily. Each item should be listed by nomenclature, stock number, other pertinent data, and unit of issue. An example is:

Nomenclature	Stock Number	Unit of Issue
Pipette:		
1 ml graduated to tip in 1/100 (1,000E Vendor's name)	10599	Box (12)
2 ml graduated to tip in 1/100 (Vendor's name)	10600	Box (6)

Note: Pipettes by size and specifications limited to particular vendors.

Each line item in each category should be listed alphabetically; then all items under each line item should be listed in consecutive order by type, size, specification, or other identification. Stock numbers should be in numerical order corresponding to the alphabetical listing.

F. Provide a suitable procedure for laboratory requisitioning. As the system is implemented, an internal requisition form, compatible with the terminology used in this paper, should be developed. A possible format is shown in Figure 2. The requestor should fill in all sections of the form except Quantity Issued, Unit Price, Total Cost of Issue, and B/O (Back Order) Quantity, if any. (The stock clerk fills in these sections.) The current unit price of the stock item should be used. If the laboratory does not desire cost data, the form can still be used for requisitioning.

G. Stock record forms should be filed by category in suitable filing equipment. Items within each category are filed in alphabetical order and in the corresponding numerical order of the stock numbers.

H. Storage control procedures should be initiated. Storage control is a must in the overall system to ensure optimum use of the limited storage space available and to facilitate the rapid filling of requisitions. Just as important is the ability to locate stock item storage points quickly for both stock loading and issuing of supplies. Alphabetical and numerical designations for these storage points placed directly on the stock record card make this possible. The derivation of the location codes is quite simple after designations have been assigned. An example follows:

Area	Alpha or Numeric Designation	Example
Storage Room	Alpha	A
Section	Numeric	5
Row	Alpha	D
Bin	Numeric	22

The location code for a particular stock item would be A5D22. The example has many variations. If there is just one storage room or area, for example, this designation can be eliminated.

Stock items should be stored by category if at all possible. Items can also be stored in alphabetical order to further facilitate finding items for rapid issuance.

I. Where obsolescence, deterioration, or spoilage of supplies is a factor, use a "first-in, first-out system" for moving supplies in

FIGURE 2
LABORATORY SUPPLIES REQUISITION

*Date: Sept. 2, 1976

*Requesting Organization: General Chemistry (G)

*Cost Center: 120

*Stock Number	*Item	*Unit of Issue	*Test, Project or Other Code	*Stores Location	Quantity *Required	Quantity Issued	Unit Price	Total Cost of Issue	B/O Quan.
10980	Pipette	Box	80	A-15-C	50	50	2.00	100.00	—

*Person Completing Requisition: Johnson

**Supervisory Approval: Stewart

*To be filled in by Requesting Organization
**Optional

and out of the stockroom.

PERIODIC INVENTORY CONTROL PROCEDURE

The following should be accomplished in the development and implementation of the Periodic Inventory Control Procedure.

A. Stock items should be categorized and identified as described in steps A and C for the Perpetual Inventory Control Procedure.

B. Stock records for inventory control and storage locations can be recorded on those forms designed for the Perpetual Inventory Control Procedure, but for this purpose the forms should be printed in a different color. The major differences in the way these forms and those of the Perpetual Inventory Control Procedure will be used are as follows:

1. The posting of detailed issue data is eliminated. As previously mentioned, entries are made only when stock is replenished, when inventory is reconciled, and when items are placed on order—each of which occurs annually or at an increment of time which is compatible with local procurement policies. In comparison, many postings are made for items controlled by the Perpetual Inventory Accounting System.
2. The initiation of replenishment action is based on visual observations of stock on hand rather than the current balance of inventory as shown on the stock record form used in the Perpetual Inventory Control Procedure. A safety stock or reserve is established, and when the inventory is used down to this reserve (as can be seen visually), procurement action is taken. In essence, this reserve quantity serves as the Order Point which can be computed in the same manner as in the Perpetual Inventory Control Procedure.

C. The requisition form in Figure 2 should be used for requesting items for the laboratory. The requestor should fill in the sections of the form as is done for perpetual inventory control items.

D. The procedures used for the Perpetual Inventory Control Procedure are also used for storage control.

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Simplification and Standardization of Laboratory Supplies—A Must for Optimum Budget Control

by Carl E. Stewart, Jr.

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Purchasing and budget control of laboratory supplies has always posed a difficult problem to laboratory administrators. With rising prices caused by inflation and increasing sophistication of materials used in testing, administrators must resort to more than just conventional ways of budget control.

Most believe that their supply problems are solved when they implement a fully operating inventory control system. In most cases, however, they seem to overlook that even in a tight inventory control situation, many items are purchased that are not needed, seldom used, or perhaps could be substituted by other items in the inventory. Controlling such purchases is a critical step in the management of the budget, and a technique to accomplish this is called "simplification and standardization" (SS). In essence, SS should be an integral part of a basic inventory control system, but this is usually not the case.

Concept of Use

Simplification and standardization procedures are widely used in industry for purposes of reducing production inventory and, thus, capital investment.[1] However, the concepts involved are just as effective for purchased supplies and materials that are stored and issued for the laboratory as for the aforementioned production inventory. A reduction of the variety and sizes of items used in the laboratory reduces costs in the supply budget as well as storage and inventory costs.

Definitions

The *simplification procedure* involves the elimination of superfluous varieties, sizes, dimensions, etc., "of items in the inventory. It is simply a reducing process, a cutting down of varieties and types"[2] of items after carefully considering their present uses and possible alternative uses.

On the other hand, *standardization* involves setting up fixed sizes, types, qualities, measures, and flow speeds, and "implies careful consideration of relationships and values, usually involving scientific procedures."[2]

Development of Procedures for the Laboratory

Although simplification and standardization procedures can be instituted at any time, it is recommended that, if at all possible, these procedures be implemented before stock records are established for an inventory control procedure. To accomplish the necessary implementation, the following steps are recommended:

1. List all items carried in inventory. This can be obtained either from purchasing records or applicable stock records.
2. Classify items by kind or use. For example, one classification could be *glassware* and subclassification could be *flask, tube,* or *pipette*. If a well-designed stock catalog is in use, classification becomes an easy task.
3. List the uses to which each item is put. One purpose of this is to determine whether different materials (glassware, plastic-ware, tubing) are used for the same or similar purposes in the various laboratory disciplines. If this is found to be true, the need for simplification is evident.
4. As an alternative to *3* above, list each step in each laboratory test procedure and the supplies and materials used for each. It may be found that many various sizes, shapes, compositions, and specifications are used to perform *similar* laboratory procedural steps. The next step is to *question* the use of all materials used and attempt optimum simplification. This may involve substitution of types and sizes of items used as well as the recommendation for redesign (a step toward standardization) of certain items for universal use and application.
5. Before final decisions are made on those items in which standardization may be necessary or where changes in specifications are deemed necessary, consider the following variables:

   a. Is the work done in each step of a laboratory procedure qualitative or quantitative?
   b. Are the following items *or* test requirements applicable?

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(1) Volume
(2) Draining time
(3) Size or type closure
(4) Accuracy of graduation and fineness
(5) Shape in regard to handling
(6) Type of manipulation required
(7) Type or nature of transfer of materials
(8) Length-width-height requirements in regard to handling and use with equipment
(9) Temperature standard or requirements
(10) Sterilization standards
(11) Storage methods
(12) Other

6. As necessary, insure that supply items requiring specification changes will be:

a. Suitable from the standpoint of the variables in #5 above
b. Obtainable from a vendor or produced with minimum difficulty by a manufacturer
c. Convenient to handle, store, and issue
d. Standard, to whatever extent feasible
e. Replaceable by substitutes if difficult to obtain within a normal procurement schedule.

Table I—Example of Group Consensus for "S&S" Decisions

Description of Item	Organization Using Item: Diag Micro	Vir	Chem	Hem	Blood Bank	SS Decision
Cylinders						
1. Graduated, 10 ml, single metric scale, 24/case; Calibrated			X			Substitute for item 3—Eliminate
2. Graduated, 50 ml, Accu-Red, single metric scale with pourout and hexagonal base; calibrated			X			Substitute for item 3—Eliminate
3. Graduated, 50 ml, single metric scale, with pour-out; calibrated	X	X	X			Use
4. Graduated, 100 ml, single metric scale, calibrated	X	X	X			Use
5. Graduated, 100 ml, lifetime red, single metric scale; calibrated			X			Substitute for item 4—Eliminate
6. Graduated, 100 ml, polypropylene, metric			X			
7. Graduated, 200 ml, single metric scale						Eliminate

Group Consensus and SS Decision Making

One of the best methods for making SS decisions is to involve representatives from each laboratory function in making analyses of use of each item. The laboratory director, assistant director, or other supervisor should act as chairman of the group to insure that an orderly approach to decision making is exercised.

From this involvement, a group consensus should be reached as

Table II—Procedural Analysis of Item Use
Procedure: *Prepare Blood Agar Base Medium* (Usually prepared in 2000 ml lots)

Procedural Step	Item Used: Code	Description	Possible Use of Alternative Items: Code	Description	Recommendations
1. Weigh specified quantity of blood agar base and add to *flask*—mix with sufficient water	10	4000 ml heat resistant flask	10	3000 ml flask	3000 ml flask standard for 2000 ml lots
2. Melt contents in hot water bath on stove	10	4000 ml heat resistant flask	10	3000 ml flask	
3. Remove flask and place in regular water bath to insure agar remains in proper form	10		10	3000 ml flask	
4. Transfer agar from flask to tubes by means of automatic pipette	10	13 × 100 mm tubes	10	12 × 75 mm tube	Eliminate 13 × 100 mm tube
			10	15 × 125 mm tube	
			10	16 × 125 mm sc tube	For this procedure use 15 × 125 mm tube
			10	18 × 150 mm tube	
			10	20 × 150 mm sc tube	Determine if remaining tubes listed can be eliminated from inventory

Table III—Analysis of Size and Incremental Graduation of Heat-Resistant Beakers for Purposes of Simplification

Group	Size (ml)	Incremental Graduation (ml)
1	10*	10
	30*	10
	50†	10
	100*	10
	150*	20
2	250*	25
	400†	25
	600*	50
3	1000†	100
	2000*	200
4	4000†	500

* Possible elimination
† Possible optimum choice for use

to which individual items can be eliminated, when a substitute can be offered from similar items in the inventory, or where standardization can be achieved. The group consensus approach not only insures fair representation of all concerned, but offers a "two (or more) heads are better than one" or brain-storming effect for optimal decision making.

Examples and Techniques of Analysis for SS Decisions

An example of the decisions made by group consensus is shown in Table I. From this table, it can be seen who uses the item, if this item can be substituted with another item in the inventory, or if the item can be eliminated from the inventory.

When decisions such as those shown in Table I are made, several techniques of analysis can be used. The most simple and straightforward is to discuss how and where each item is used, if another item can be substituted, or if changes can be made so that an item can be standardized for use by several organizations, thus eliminating a number of items from inventory. Such discussions may involve how items are used in specific procedures. Agreement may be reached as shown in Table II. Although such detailed analyses are time consuming, the benefits may prove substantial.

Table IV—Analysis of Size and Incremental Graduation of Regular Heat-Resistant Glass Cylinders for Purposes of Simplification

Group	Size (ml)	Primary Graduation (ml)	Secondary Graduation (ml)
	10†	1	.1
	25*	.1	.2
2	50*	5	1.0
	100†	10	1.0
	250*	20	2.0
3	500†	50	5.0
	1000*	100	10.0
	2000*	200	20.0

* Possible elimination
† Possible optimum choice for use

Other techniques may involve a more quantifiable approach, such as identifying sizes, increments, and weights, and analyzing item requirements in relation to such quantifiable elements. A simple example of such an approach is shown in Table III. In this table, a number of sizes of heat-resistant glass beakers, like the ones presently used in a large laboratory, are listed. When the procedural uses and the possible *combinations* of these uses are analyzed, it may be possible to eliminate a substantial number of beaker sizes from the laboratory inventory.

A preliminary step in such an analysis would be to group sizes by incremental graduation where interchangeability of use is possible. As seen in Table III, 11 sizes are combined into four *groups*, and there is a possibility that four *sizes* can be used in lieu of the 11, thus eliminating seven sizes of beakers from the inventory. For example, in group 1, the 50-ml size with an incremental graduation of 10 ml can be used in lieu of the 10-, 30-, 100-, and 150-ml size since the increments of these sizes are in multiples of 10 ml. Incremental multiples are also considered in the remaining three groups.

The final decision as to which sizes in each group should be eliminated may depend on a more thorough analysis which will consider the nature of the procedure in which the item is being used, as well as the time and volume of use. For the most part, however, the incremental analysis may prove to be sufficient.

Two additional possibilities stand out at this point in the analysis of the beaker inventory. First, the graduated increments which serve to increase the cost of the beakers might be eliminated since, for the most part, they are not used for measuring but prin-

cipally for *mixing* ingredients. Second, flasks in the inventory may be substituted for those beaker sizes eliminated, thus providing a full range of common container volumes without increasing the overall inventory.

Another specific example of simplification would be to reduce the number of sizes of heat-resistant, graduated glass cylinders used in the aforementioned large laboratory. Table IV lists these cylinders by size and graduation.

When the procedural uses and the possible combinations of uses are analyzed, it can be seen that certain sizes can be eliminated from the inventory, either by using larger or smaller size cylinders or by substituting another item of equipment. For example, in many cases a graduated pipette can be used in lieu of the 10 ml cylinder. Also, when the flexibility present in the primary and secondary incremental graduations is considered as it was in Table III, certain cylinder sizes can be eliminated.

As indicated previously, these choices still depend upon many factors, but in many laboratories, such an analysis should be sufficient for making simplification decisions.

Another possibility to consider in analyzing the larger-sized cylinders for use is that accuracy is not as critical as in the smaller-sized cylinders. If such accuracy is demanded in these larger sizes, then it may be necessary to use volumetric flasks.

Another consideration is the cost of the larger-sized graduated item, which in many cases may be triple that of the next lower-sized item. Therefore, a primary objective of the personnel performing simplification procedures is to limit the number of larger-sized items used.

One method of accomplishing this would be the use of a mathematical system of preferred numbers[3] to determine sizes. Preferred numbers are geometric progressions in size from small to large with each number in the series being proportionally larger than the preceding number. A geometric series, which provides several small sizes but holds the number of large sizes to a reasonable number, generally meets the requirements of users better than arithmetic progression.

Before the proper proportion to use can be determined, the largest and smallest size in stock and the number of sizes in between must be specified. The following formula, where n is the total number of sizes to be stocked, gives the proper ratio between sizes:

$$\sqrt[n-1]{\frac{\text{Largest size}}{\text{Smallest size}}}$$

For example, the existing span shown in Table III between the smallest and largest sizes might be retained, but the number of sizes might be reduced to five. (Note that the Table II methodology reduced the number of sizes to four.) The formula then yields:

$$\sqrt[4]{\frac{4000}{10}} \text{ or } \sqrt[4]{400} \text{ or a ratio of } 4.47.$$

Each size to be stocked, then, is approximately four to five times the size of the item immediately preceding it in size.

For example, the five sizes derived from Table I would be:

Size (ml)	Incremental Graduation
10	10
50	10
250	25
1000	100
4000	500

This stocking pattern is quite similar to that derived in Table III, although the preferred number to be stocked was determined somewhat arbitrarily.

Care must be used with the preferred number methodology because of the variances in incremental graduations. However, it should be of use for many items other than glassware. Experience will, of course, be necessary in evaluating the use of such a mathematical system.

Standardization is a follow-up to simplification; an example would be the establishment of a standard size, material content (glass, plastic, metal) weight, and incremental graduation for beakers and cylinders for use in the various laboratory functions. For example, plastic cylinders can be used in place of glass cylinders to eliminate the high cost of breakage.

Basic sizes and related considerations such as quality of materials could be established for all items (vials, prescription bottles, pipettes, gauze, aluminum foil, and rubber or plastic tubing) used in the laboratory.

It should be noted at this point that simplification can be accomplished *without* the use of the standardization procedure for the great majority of items in the inventory; however, both procedures must be considered simultaneously for necessary items of special use so that they will not be eliminated from the inventory. Then, too, in many cases standardization procedures will not be necessary since sizes and material standards have been fixed—and are necessary—for certain protocols.

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A DECISION SYSTEM FOR ESTABLISHING

SERVICE LEVELS IN A HOSPITAL LABORATORY

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The cost of clinical laboratory services constitutes an appreciable portion of medical care costs, and physicians are relying more and more on these services for the diagnosis and, indirectly, treatment of their patients. Unless these strategic services are *efficiently* as well as effectively used, significant limitations will be placed on the physican's capability to deliver quality care, and patient care costs will increase.

A system is needed by which medical and management personnel in a given hospital can determine how best to provide necessary and appropriate laboratory services. The Center for Disease Control (CDC) developed such a system in connection with a laboratory management study conducted in 1967 for the Indian Health Service. The system was modified as a result of the Conference on Laboratory Services for Small Hospitals held at CDC in October 1970. Conference participants recognized the value of the system and recommended that it be expanded for use in all hospitals.

The system described here is so designed. Its primary purpose is to allow the laboratory director and hospital management and medical staff to avoid duplication of services and inefficient assignment of scarce trained laboratory personnel, space, and expensive equipment. It should also raise the quality of laboratory services by eliminating the performance of the more difficult tests by inadequately trained personnel and by avoiding excessive or open-ended work load assignment. Furthermore, the system permits the elimination of certain tests that are now performed, as well as the sending of certain tests to a referral or independent laboratory that would provide more effective and less costly services. It is also considered highly useful for establishing service levels for new laboratory facilities in a hospital under construction and in developing countries.

In brief, the system is composed of a list of decision-making criteria by which local decisions can be more easily made by a value judgment process. The process can determine *specifically* which tests should be accomplished in the hospital laboratory, which tests should be sent from the hospital laboratory to a referral or independent laboratory, public health laboratory, or other appropriate laboratories such as the CDC, and which tests should be eliminated. These criteria, divided into four categories — Medical Needs, Legal or

DECISION WORKSHEET

Should this test be done in this hospital laboratory when judging the following criteria?

Criteria	Tests			
	Hemo	Rubella	TGT	T-3
	Yes No	Yes No	Yes No	Yes No
I Medical Needs				
A. Type Services Rendered	✓	✓	✓	✓
B. Type Disease Prevalent	✓	✓	✓	✓
C. Immediate Diag. & Treat.	✓	✓	✓	✓
D. Diagnostic Confirmation	✓	✓	✓	✓
E. Epidemiological Consid.	✓	✓	✓	✓
F. Clinical Research	✓	✓	✓	✓
II Legal or Professional Req.				
A. State & Local Laws	✓	✓	✓	✓
B. Professional Certif.	✓	✓	✓	✓
C. Quasi-Legal	✓	✓	✓	✓
III Technical & Personnel				
A. Identical Tests	✓	✓	✓	✓
B. Equip., Methods, Reag.	✓	✓	✓	✓
C. Exper. & Comp. Pers.	✓	✓	✓	✓
D. Lack of Recent Exper.	✓	✓	✓	✓
E. Workload	✓	✓	✓	✓
F. Safety	✓	✓	✓	✓
G. Stab. & Trans. of Spec.	✓	✓	✓	✓
H. Trans. of Patient	✓	✓	✓	✓
IV Managerial Considerations				
A. Avail. of Svcs. Elsewhere	✓	✓	✓	✓
B. Efficient Use of Resources	✓	✓	✓	✓
DECISION: Eliminate			✓	
Do In-House	✓			
Send Out		✓		✓
Other				

This "decision worksheet" provides the basis for formal evaluation of efficient service levels in the hospital laboratory. See text for details on how this format is used to determine whether to "eliminate," "do in-house," or "send out" laboratory tests.

Professional Requirements, Technical and Personnel Considerations, and Managerial Considerations — are described below.

Medical needs

This first category — medical needs — consists of six important criteria which must be dealt with in the decision-making process.

Type of services rendered. This criterion entails a decision by the hospital on its role in the delivery of health care and the type and scope of services it must render. For example, a hospital may serve as a large referral center or may offer only specialty services. A large referral hospital may have to offer laboratory tests not routinely needed by a smaller general or community hospital Conversely, a specialty hospital or a hospital servicing only a specific type of patient or limited patient population may eliminate tests not appropriate to their patient population.

Type of disease prevalent in area. The prevalence of certain diseases in the community may necessitate that certain laboratory tests be available to the physician. In an area with certain endemic infectious diseases, the physician may require diagnostic laboratory services not needed elsewhere. For example, services for coccoccidioidomycosis might be needed in the southwestern United States. Another example is that tests for certain diseases prevalent in a patient population might be needed; diabetes tests, for instance, might be called for in a patient population of American Indians.

Need for immediate diagnosis and treatment. Certain laboratory tests must be made available to the physician for him to arrive at a decision involving immediate therapy, hospitalization, or both. A minimal response time is usually necessary for these tests to be accomplished. A general example would be the request for tests from an emergency room. Specific examples would be tests for serum electrolyte levels in a dehydrated patient and a hematocrit or hemoglobin level in a patient with acute trauma.

Diagnostic confirmation. Certain tests may be necessary to confirm a diagnosis, indicate need for further treatment, or guide therapy. These tests may also guide the physician to patterns of disease and thus influence treatment of future patients. A general example would be tests for the antibiotic sensitivity of an infectious agent isolated from a patient. A specific example would be the test or procedure for defining the appropriate reagent for a staphylococcal infection. Another example would be a test confirming that a disease recently prevalent in a community is a viral disease and thus does not require antibiotic therapy.

Epidemiological considerations. Tests for diseases that require epidemiological and / or public health control must be considered. A general example would be tests for certain contagious diseases. Specific examples are brucellosis, typhoid fever, and certain gastrointestinal infections. When evaluating this criterion, laboratory services furnished by a local, area, or state public health laboratory should be considered.

Clincial research. This criterion concerns laboratory services that do not require rapid response or are not related to those given above, but serve to characterize patient population parameters in relation to disease and thus advance the medical knowledge about a unique group. A general example is the study of the increased incidence of genetic disorders among inbred populations such as the Amish. Similar studies could be performed in a hospital in a certain locale. When examining the previous and remaining criteria, however, it may be found that most, if not all, of the tests should be done outside of the hospital laboratory.

Legal or professional requirements

State and local laws. These laws may require that certain tests be performed in the laboratory to meet minimum requirements for operation of the hospital. For example, state law might require a laboratory facility in each hospital for emergency work such as that for urinalyses, hematology, blood typing and cross matching. One or more of the criteria listed above and below may override the need for one or more of the tests required by state law. An effort should then be made to change the law to provide more flexibility.

Professional certification. Certain tests must be accomplished to obtain approval for training or professional recognition. For example, hospitals having schools of medical technology must ensure that certain tests are performed in order for students of medical technology to obtain the experience necessary for certification.

Quasi-legal requirements. A physician may order tests not covered by the preceding criteria to insure thorough diagnostic coverage and thus eliminate possible medical-legal litigation, not only for himself, but for the hospital. For example, he might order tests to detect hepatitis carriers in the blood donor population.

Technical and personnel considerations

Availability of other tests revealing identical or comparable information. In some instances, identical diagnostic implications are available in two or more tests; therefore, only one of the tests is actually necessary. For example, in screening for hepatitis, a transaminase test may offer as much information as an entire battery of liver tests. Another example is a partial thromboplastin time assay and a thromboplastin generation time assay, only one of which is needed.

Availability of adequate equipment, methods, and reagents. Adequate equipment and reliable reagents must be available if a test is to be properly performed. For example, a certain pediatric microbilirubin method requires a narrow-band spectrophotometer and specified standards and reagents for its calibration. If these items are not available, the test cannot be properly done. Similarly, the identification of irregular antibodies in a serum specimen requires constant maintenance of expensive reagents which have a limited shelf life.

Availability of experienced, competent laboratory personnel. Personnel on duty may be nominally qualified for a particular classification of tests but may not have had the experience required to handle other procedures. In such cases certain tests would be sent to another laboratory until the personnel received additional training or gained proficiency through repetitive experience.

Lack of sufficient and recent experience to maintain proficiency. This criterion applies chiefly to situations in which certain tests must be run often enough or in sufficient quantity for the laboratory worker to maintain proficiency. An example is the "prothrombin time" test in which the procedural steps and the detection of the end point are difficult. If this test is performed infrequently, it may be best to stop performing the test and have another laboratory do it.

Work load. To maintain adequate response to medical needs and adequate quality of performance, the variety and quantity of tests must be limited. An overload leads to inaccurate work, less quality control, and inappropriate referral.

Safety. If proper safety equipment such as fume hoods, biological safety cabinets, and isolation areas are not provided for examining specimens containing dangerous bacteria, either the specimens should be sent to a properly equipped laboratory or the proper equipment should be purchased and installed.

Stability and transportation of specimens. Before a specimen is sent to another laboratory for examination, the stability of the specimen and the means of transporting it must be considered. The ability to stabilize the character of the specimen, ensure proper preparation and handling procedures, the mode of transportation, distance, shipment time, and other considerations are critical.

Transportability of patient. This criterion applies to the situation in which it is more economical and more convenient to send the patient out to a particular hospital or clinic laboratory for drawing the specimen and testing it.

Managerial considerations

Availability of acceptable services elsewhere. These services may be of two types: (1) Those offered by a state, county, city, other local, or federal public health laboratory with minimal or no charges, and (2) those offered by a referral or independent laboratory or by exchange agreements with other laboratories. An example of the latter would be an agreement between two or more hospitals for each of the hospitals to specialize their facilities for certain tests and then perform these tests for all hospitals concerned.

Most efficient use of resources (personnel, space, equipment, supplies, utilities, etc). This criterion will serve as the deciding factor for many of the tests now being accomplished or proposed. When "costing out" the use of resources in performing tests, it may be found, for example, that a routine series of tests now costing $15 can be done at an independent laboratory for $6. This is usually the case in a laboratory with small work load and an expensive item of equipment requiring high technical competency, a substantial amount of scarce and high cost space, and expensive upkeep. Every effort should be made to compare costs of tests done in-house with those done elsewhere to determine if the criterion of efficiency should override other criteria.

How to use the system

The first step in implementing the system is to select a decision-making committee from the hospital's medical and management staff. This committee should be composed of the hospital administrator, the laboratoı director, and selected physicians either serving on th hospital staff or using the hospital.

Before the committee's first meeting, the hospit administrator in collaboration with the laborator director should have the following pertinent informatio available for use by the committee: (1) laborator staffing, space, and equipment statistics; (2) supply reagent, maintenance, utility, and other costs o operating the laboratory; (3) list of tests performed; (4 frequency of tests performed, showing daily, weekly monthly, and seasonal frequencies; (5) unit cost fo performing each test; (6) patient charges per test; (7 equipment and instrumentation utilization data; (8 training costs and projected training requirements fo laboratory personnel; (9) proficiency testing results; (10 location of referral and independent laboratories, test performed by these laboratories, charges if contractural or other agreements are entered into, quality of these laboratory services, and speed of response.

During the first meeting, the administrator should explain the purpose of the decision system, how to use the system, and what is expected of the committee. All questions about the mechanics and philosophy of the system should be answered at this meeting.

The committee should be ready to establish laboratory service levels by the start of the second meeting. At this meeting, with the administrator, laboratory director, or responsible physician presiding, each laboratory test performed in the laboratory should be thoroughly examined and scrutinized by asking the following question for each of the criteria listed: "Should this test be done in this hospital laboratory?" A "yes" or "no" answer to this question is yielded for each of the criteria listed by the committee's value judgment when using the definitions of the criteria, the economic and management data gathered before the first committee meeting, and the best experience of all members of the committee.

Special care should be exercised in deciding whether the answer to the question, "Should this test be done in this hospital?", is "yes" or "no." A "yes" answer for one criterion means that the test should be done; a "no" means that it should *not* be done. A final value judgement is made by carefully judging the values of the yeses and noes and then making a decision to "do in-house," "send out," or "eliminate."

Specific examples of application

Certain laboratory tests performed in a hypothetical general hospital will be considered to show how a decision can be reached to "do in-house," "send out," or "eliminate" the tests. This 200-bed hospital is in a city of 40,000. It is within 50 miles of a city of 500,000 which has a state public health laboratory, many private laboratories that have excellent referral capability, and many general and specialty hospitals. One other general hospital in this small city has a capability comparable to that of the hypothetical hospital. The tests used as examples are those for hemoglobin, rubella, thromboplastin generation time, and T-3 uptake. The results of the value judgments for these four tests are tabulated on a decision worksheet shown in the accompanying

illustration. The reasoning behind the decision made for each test is summarized as follows:

Hemoglobin. The committee decided to continue performing the hemoglobin test, since most physicans concerned agreed that it was needed because of the immediacy of situations calling for the test and because state and local laws required that it (or a similar test) be performed. Futhermore, the majority of managerial and economic factors favored its being done in this hospital, since capable people were on hand to do the test, the test was inexpensive, and expensive equipment and space were not required for the test.

On the other hand, epidemiological, clinical research (no research was done in this hospital), professional or quasi-legal, and identical test considerations indicated that the test should not be done. Concerning the latter, the committee recognized that a hematocrit test would give the results necessary for immediate diagnosis and treatment, but physicans agreed that both hemoglobin and hematocrit tests were needed for more definitive diagnoses. The committee also found that the specimen was stable for transporting and that a crosstown hospital responded quickly, if necessary. (Note the "yeses" and "noes" on the decision worksheet. A compromise decision would have been to eliminate the hematocrit test and send specimens to the crosstown hospital.)

Rubella. The committee decided to send out specimens for rubella tests. Although there was a medical need for the test, the committee decided that the laboratory technicians were not competent to perform it because of lack of training and lack of opportunity to maintain proficiency. In addition, the cost of performing a limited number of tests annually was very high, and the rubella test was available free of charge at the state public health laboratory in the city. (Note that the noes on the decision worksheet far outweigh the yeses.)

Thromboplastin generation time assay (TGT). The committee decided to eliminate the TGT. It found a medical need for the test; services for the test were not available elsewhere, and the test could be done economically in this hospital. However, the committee also found that the information derived from the test was basically identical to that given by the partial thromboplastin time test (PTT). The PTT was done in the hospital. The decision clincher at this point was the availability of another test with identical or comparable results. (Note again the relationship of the yeses and noes in the decision worksheet.)

T-3 uptake. Although the T-3 uptake test was not done in this hospital, several physicians expressed a desire for the test; however, the committee decided to send out the specimens for the T-3 uptake test. Furthermore, the laboratory director had a technologist competent in performing this assay. The committee learned, however, that a nearby private laboratory could perform this test competently and at less cost than if it were done in the hospital. The committee also ascertained that the test was not necessary for immediate diagnosis and treatment and was chiefly used for diagnostic confirmation. On the decision worksheet, the noes far outweigh the yeses, but the clinching value judgement was derived from the availability of high quality, economical services elsewhere and the lack of *immediate* medical needs in the hospital.

Results of committee work

Hypothetical final results of the hospital committee's work on all presently performed or suggested tests are:

1) Thirty-two tests will be sent out to private laboratories on a contract basis.

2) Ten tests will be sent to the state public health laboratory.

3) Patients will be billed directly for the tests performed from the private laboratories. Patient cost is thus reduced, since the costs per test are lower and since this hospital has decided not to place a surcharge for profit on those tests sent out.

4) Space for more x-ray equipment has been made available from that saved in the laboratory.

5) Overtime costs for laboratory personnel have been almost eliminated.

This formal procedure developed by the Center for Disease Control is essentially a decision system in which group value judgments are used. Its use should raise the quality of servces and increase efficiency in all hospital laboratories. □

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