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ANNEX 5.11

HEALTH FACILITIES MAINTENANCE

GUATEMALA HEALTH SECTOR ASSESSMENT

November 1977

LAC/DR/N

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Annex 5.11

HEALTH FACILITIES MAINTENANCE

I. DESCRIPTION OF PROBLEM

Overview. The Ministry of Health (MOH) has approximately 37 hospitals, 159 health centers; 470 health posts, and a broad scope of support services. To determine the level of maintenance in these facilities field visits were made to a representative sample. It was found that a substantial percentage of the equipment in the health facilities is either not installed, and therefore not being used; being improperly utilized and/or maintained; or has reached a state of complete disrepair.

In almost every hospital or health center visited there is new equipment, purchased by the GOG, USAID/G, or other international assistance programs, which has not been installed. In some cases this equipment arrived damaged and is unusable; in others it does not match the primary energy source of the facility, and major alterations will be required if the equipment is to be operational.

Lack of maintenance is affecting all areas of the service support base. In many laboratories visited there was inadequate equipment to perform tests in a reliable manner and contamination of specimens is likely as facilities and equipment are inadequate for properly cleaning, rinsing or drying the glassware. Maintenance support of the laboratories is virtually non-existent.

X-ray equipment is rapidly losing its value as a diagnostic tool. There is essentially no regular testing of the X-ray alignment or calibration of the controls; without these tests it is impossible to know the exact direction or intensity of the X-rays. Although these tests should be conducted regularly, X-ray maintenance in the urban areas is performed only when the equipment does not function and X-ray repair capability in the rural areas is marginal because the private, contract technicians rarely respond to calls.

Sterilization equipment and laundry facilities also operate at reduced efficiency and lowered standards, because adequate maintenance support is unavailable, especially with respect to adequate tools and spare parts.

In all cases, maintenance and repair manuals are not available; spare parts are difficult to acquire; appropriate tools are not available; and virtually all maintenance is performed, at their convenience, by the private vendors/distributors of the equipment.

A. PROBLEM DEFINITION: The poor condition and/or inefficient use of the MOH equipment appears to be a direct result of the fact that the Ministry of Health has no centralized maintenance program to plan or implement the services necessary to maintain the physical facilities and equipment already in existence, nor to systematically plan the construction of, and equipment for, new facilities. Because of this:

a. Equipment already in existence is non-functioning, or is rapidly deteriorating.

b. Equipment selection for newly constructed facilities is often made after the basic building plans are drawn or the building is completed; in many cases the building's mechanical systems are inadequate to handle the equipment received, or the administrator has neither an adequate budget nor the proper personnel to accomplish the highly technical installation.

c. There is no standardization of equipment among hospitals, or even within hospitals, which makes it difficult to obtain spare parts or standardized training and maintenance procedures.

d. New hospitals are being constructed and equipped with no input from trained hospital engineers who are able to use the construction experiences of other GOG hospitals to improve the construction of new facilities.

e. There is a shortage of engineers and technical personnel oriented toward hospital facilities planning, and maintenance of medical facilities and equipment. Additionally, other sectors of the government, such as IGSS, Bienestar Social, and the Army, as well as private hospitals, clinics and PVOs, duplicate health services and compete for the use of the limited group of trained personnel which exists.

f. The need for technical expertise and the cost of altering facilities so that existing equipment can be used exceed the present financial and technical resources of the MOH.

I. B. AVAILABILITY OF INFORMATION

Financial Information: There is no centralized collection and analysis of data describing the maintenance costs for MOH facilities and equipment. The 1976 MOH budget for the support and maintenance of facilities was reviewed as a means of obtaining an estimate of MOH costs for maintenance. This budget lists planned expenditures for materials and supplies but it does not indicate how these materials will actually be allocated to the maintenance and repair functions. Additionally, the system used by the MOH for accumulating real expenditures does not allow the aggregation of expenditures solely used for maintenance.

Status of Equipment and Facilities: Inventories of facilities and equipment are maintained only in the Comptrollers Office to substantiate capital assets. There are no lists indicating the actual condition of facilities and equipment, nor the age of the equipment and its life expectancy. Without such information the budget preparation for maintenance needs is largely arbitrary. (See Appendices 1 (a) through 1 (i) for MOH 1976 Regional Budget Allocations.)

I. C. COMPARISON OF THE SITUATION WITH GOG PLAN OBJECTIVES IN MAINTENANCE OF HEALTH FACILITIES AND HEALTH FACILITY EQUIPMENT

1. The GOG has no written plan to provide improvement to, or maintenance of, its health facilities or equipment, nor to provide an engineering adjunct to the staff of the Ministry of Health. The MOH recognizes the need for such a plan but has not yet determined the appropriate approach to its development.

2. The National Economic Planning Council of the GOG recognizes the need for a planned health facility maintenance program and has been involved through its staff members in the drafting of this paper.

3. It is the goal of the MOH to extend its health services to increased numbers of the population. (See Plan de Desarrollo, 75/79: Plan Nacional de Salud, Tomo I.) Lack of an adequate maintenance program will lead to ineffectively-delivered services and will increase dramatically the cost of delivering these services.

II. ANALYSIS OF THE PROBLEM

A. CAUSES: The causes of the problem are multiple, but each can be related to the absence, on the national level, of a centralized maintenance program.

First, the coordination between the MOH and Obras Publicas (Department of Public Works) with respect to health facility planning is minimal. Yet, new facilities are built by Obras Publicas and then transferred to the MOH for ownership and operation.

The MOH does not have the trained experienced personnel necessary to ensure that specific requirements for health facilities are programmed into the Public Works planning process. Likewise, Obras Publicas is not experienced in the development of a complete and well-coordinated service base needed if the hospital is to function and be maintained efficiently and effectively. Space for maintenance personnel and operations is sometimes eliminated.

Special building code requirements (such as color-coding electric wiring and putting in an adequate ground system) are ignored in the planning process. Windows are included where they do not belong. Equipment is not sized before facilities are built.

After completion, transfer of these facilities is made without a competent inspection for deficiencies, and without a transfer of blue prints, equipment manuals, or any of the manufacturer-supplied tools or materials. For example, at Cuilapa not a single bit of informative material is available to operate a new multi-million dollar building. There is no systematic process for, nor MOH official designated to oversee or receive, the timely and complete transfer of materials, and they are quickly lost or misplaced. At Coban the spare-part nomenclature for several hundred newly-delivered hospital beds has disappeared. It is likely that the laundry equipment, kitchen equipment and boilers, soon to arrive, will experience similar problems.

Second, improvements and alterations to the buildings are made without study or planned design. Often the hospital personnel lack adequate information about the purpose of new equipment and may be completely without the financial and technical capability to initiate installation. The failure to provide competent engineering input to facility alteration and maintenance has resulted in a backlog of alterations greater than the MOH has funds to finance or has technical ability to execute.

USAID/G also, on a much smaller scale, has prepared and executed equipment plans based upon the analysis of need completed by the MOH. The fact that this equipment is not installed, or is improperly installed, highlights the need for more technical engineering capacity on the USAID/G staff.

Third, equipment is delivered to facilities without a responsible acceptance procedure. Much of the equipment arrives broken, damaged, or with missing parts. No installation, operation or maintenance manuals are delivered with the equipment because the vendors have a vested interest in keeping the manuals so that they must be called to do repairs or maintenance. There are no manufacturer-supplied spare tools, spare-part nomenclature lists, nor materials for "start-up".

Fourth, there is a shortage of technically-trained maintenance personnel, and no comprehensive training program to develop this personnel. There is a great demand, at higher salaries than the MOH pays, for those trained personnel which do exist due to the growth of industry and raw material processing plants incident to the industrial development of the country and the country-wide construction programs.

Fifth, there is no engineering component within the MOH itself. Therefore, there is no program to plan, support or evaluate a hospital maintenance and alteration program. Those maintenance technicians who are assigned to MOH facilities have no superior with whom to discuss technical problems nor priorities for action

when a technical understanding of the situation is essential. Maintenance is performed through a vendor-consumer relationship comprised of knowledgeable vendors and non-technical personnel in the MOH; according to the IGSS engineer, with this type of arrangement it costs $16 for a 40-cent gasket.

II. B. INTER-RELATIONSHIPS WITH OTHER ELEMENTS OF THE HEALTH SECTOR

The lack of a central maintenance department largely precludes any vigorous relationships with other elements of the health sector with respect to maintenance. To determine what relationships may exist, visits were made to the following places:

Department of Human Resources (within the MOH): The Director is awaiting information on the hospital maintenance training program currently being developed by INTECAP.

INDAPS (within the MOH): While the functions of this group are broader than the field of maintenance, they have provided two essential maintenance services. First, they have provided three months of formal training at the school in Quirigua to the senior maintenance technicians of hospitals. Unfortunately they are not able to provide the tools, spare parts or organization needed for strong coordinated support of their graduates.

Second, they provide an equipment repair service to outlying hospitals and health centers by providing one technician to whom the health facilities send equipment in need of repair.

BID-MOH Component: The BID program for new hospitals equipped with sophisticated medical equipment points heavily at the need for

a central MOH maintenance staff and maintenance program. Yet the BID loan to the MOH for health facilities construction provides no plan for thorough, ongoing maintenance and only six four-month becas for limited training of a health maintenance staff. Without a trained maintenance engineer or maintenance division within MOH to provide planning input to the BID program, the proper shops, tools, test equipment and materials necessary to provide maintenance support are not included in the funded programs and Guatemala loses a significant portion of the largess of the BID program.

INTECAP (within the MOL): This vocational/technical training organization now has two former hospital engineers teaching maintenance classes in the evening; the number of students is unknown. In the absence of an MOH maintenance organization, INTECAP relies on INDAPS for information, which is marginal since INDAPS has no engineer with health maintenance experience. Technical input to INTECAP on health facilities maintenance is provided by a civilian engineer, formerly employed by the Ministry of Health, who was trained under earlier maintenance programs in the country.

In March 1977 INTECAP stated they would form a committee of representative organizations to study the problem of hospital maintenance and would call a meeting of all hospital directors who would be asked to provide an equipment inventory so that work could begin on the development of a scope of work addressed to the health facilities maintenance needs in Guatemala. To date, not much activity has occurred in this area.

Other Agencies or Organizations: A number of other agencies or organizations are involved in health facility maintenance but there are no working relationships between themselves or the other health-related agencies. These include:

1. BIENESTAR SOCIAL - under the office of the President
2. INSTITUTO GUATEMALTECO DE SEGURIDAD SOCIAL-IGSS (Guatemalan Social Security) within the Ministry of Labor

   Because IGSS is unionized, if the laundry system at IGSS hospital breaks down, the laundry must be sent to Guatemala City rather than use the laundry facilities at the closest national hospital, which is sometimes in the same town as the IGSS facility.
3. EJERCITO DE GUATEMALA (Guatemalan Army) - which maintains its own hospitals and health facilities.
4. COMITE NACIONAL PRO-CIEGOS Y SORDOMUDOS (National Committee for the Blind, Deaf and Dumb) - a lottery-supported group with a network of facilities, including surgical facilities.

II. C. PROJECTION OF THE SITUATION IN FIVE TO TEN YEARS IF NO NEW ACTION IS TAKEN

1. If the present system of maintenance continues, it is inevitable that the health sector will need to prematurely replace the entire equipment infrastructure in all the hospitals. The cost to replace equipment whose life has been significantly reduced due to lack of maintenance, in addition to the cost of the new equipment planned for

health facilities expension, will more than double the equipment budget of the MOH.

2. The life of the health facilities will be seriously shortened and costly renovations will be needed prematurely.

3. The twelve hospitals to be built under the BID loan, which will contain the latest and most sophisticated medical and patient support equipment, will not be maintained.

4. The development, education and training of engineers responsible for the maintenance and operation of the health facilities will be five to ten years behind where they are now and the equipment and facilities will be in a worse state of deterioration.

5. Maintenance technicians will not have completed training early enough to be available upon the completion of new buildings.

6. If the present trend continues for 10 to 15 more years many hospitals will cease to offer X-ray due to lack of accessories or failure of equipment and diagnostic X-ray services will be available only in Guatemala City.

7. Unless changes are made, a costly boiler replacement program will be forced upon the MOH. The types of boilers in use require excellent care; at present they are fired as a "push button" operation and receive no care. The only boiler manual found during the field trip was at Roosevelt Hospital and that boiler was out of commission due to tube failures. Without a boiler maintenance/cleaning program fuel costs of boiler operations will escalate because scale build-up on the water side and soot and unburned products of

combustion on the fire side very effectively insulate the heat transfer surfaces in the boilers.

8. The quality of health care delivered at each level will decrease rather than increase. When equipment fails, tests are not reliable, surgery anaesthetics are administered by guess, X-rays are marginal, staff personnel and patients are not properly protected against X-ray hazards, and sterilization of instruments declines.

9. Lack of morale will grow in isolated areas where service maintenance is almost totally lacking and exchange of information is impossible. Turnover of maintenance staff will be a problem because pay is low and support is non-existent. The loss of the relatively few maintenance technicians which do exist, without a program to train replacements, will further accelerate the deterioration of health care services.

III. PROPOSED ACTIONS AND PROGRAMS

A. PROGRAMMATIC APPROACHES TO MODIFICATION OF EXISTING SITUATION.

USAID/G and MOH must develop methods to ensure that the equipment they provide to hospitals and health centers supports better medical care rather than create a liability in the tenuous maintenance effort.

The MOH has expended large sums of money to build and equip hospitals and health facilities. Yet, in almost all of the hospitals and health centers visited items such as dental X-rays, boilers, laundry equipment, sterilizers, stoves and similar equipment are not

operable because the equipment was purchased and delivered without consideration of power sources, space availability, installation plans or funds for installation. The material has been delivered without installation instructions, maintenance manuals, or spare parts identification lists.

The USAID program to augment MOH equipment was not adequately planned nor was a forceful follow-up made to ensure that the equipment achieved its purpose. The Administrator at the Jalapa hospital estimated that he needs more than $60,000 to install the USAID equipment which has been delivered there and he does not know the details of the overall systems intended by USAID for which the equipment was provided or if all components of the equipment are on hand.

The hospital construction program submitted to BID by the GOG includes the construction of seven thirty-bed hospitals, two fifty-bed hospitals and three one-hundred-bed hospitals but it includes no maintenance program; only one or two persons are provided for maintenance.

The following pages detail the programs proposed to address the problem of health facilities and equipment maintenance in Guatemala. The programs discussed include (1) the addition of a hospital engineer to the health planning staff of USAID/G; (2) the development of a health facilities maintenance program, and (3) the establishment of a short-term health facilities maintenance training program to increase the numbers of trained maintenance technicians and engineers.

1. Hospital Engineer Attached to USAID/G: A competent hospital engineer should be attached to the USAID/G Public Health Division staff to support the facility, equipment, and vehicular aspects of the USAID/G health sector activities. Although the USAID/G Public Health Division is an advisory and not an executive office such as the Programs Office, an engineer in this office could work more closely with, and guide, the appropriate offices of the Ministry of Health.

Since it is unlikely that the BID program foresaw a separate maintenance force solely for BID-financed hospitals, and since there is no engineering component within the MOH, USAID/G should initiate action toward including the BID program in a national maintenance program. The USAID engineer would facilitate this.

2. Establishment of a Health Facilities Maintenance Program: In order to avoid the costly duplication of maintaining comparable health facilities by various departments or agencies of the GOG, a national organization should be established which would be supported by proportioned contributions from the individual departments and agencies of the government which now provide independent health services.

A national policy on health facility maintenance should be issued at a high level which covers all the departments and agencies responsible for the delivery of health services and which gives the MOH authority to initiate the budget changes necessary to establish a maintenance program. The policy should ensure that:

- Proper use is made of facilities and equipment;
- Equipment is available when needed;
- Full-term life of the facilities and equipment is realized;
- Maintenance is conducted efficiently and economically.

Because engineering and technical programs require a measure of discipline not found in traditional business or professional programs, it is recommended that the military enter initially into the national maintenance program for these reasons:

1. The military are experienced in the type of functional training needed for health facility maintenance; the military academy (Escuela Politécnica) is basically an engineering and technical school which can produce the type of leader required for logistic support to the health services.
2. The military have a well-developed transportation and stockpile system designed to overcome difficult terrain and isolation problems.
3. The military have foreign training sources available at less cost than other departments.
4. The financial position of maintenance personnel can be improved and a pension program ensured which would not only improve morale but might reduce the turnover of technical personnel.
5. There would be less changeover of key administrative personnel with each change of government.

Whether the military are used or not, the wasteful duplication which now exists should be brought to the attention of the GOG for resolution.

If a national maintenance organization is not established as recommended, then a maintenance organization within MOH must be established which would make available the full and economic use of facilities and equipment in support of the national health programs and the improvement of those facilities to meet future health requirements.

Without a maintenance organization to plan, execute and analyze the support of facilities and equipment the MOH relies on private vendors who repair equipment at their convenience and at a considerable profit. While service is available in the Capital, vendor visits in the outlying regions are rare.

In order to insure that maintenance is performed adequately and effectively in all areas of the country, regional maintenance programs are essential. A minimum of three regional maintenance repair centers is recommended: one for the Eastern Region, one for the Western Region, and one for the Central Region, including the Capital. A sub-region should be set up under the central region to focus on the Coban and Salama areas because of the planned increase in hospitals there, as a result of oil development.

Each regional maintenance center would consist of a maintenance workshop staffed with a Regional Maintenance Engineer and trained technicians to support an improvement program, a repair program,

and a regional preventive maintenance program. These centers will also provide on-the-job training for new maintenance technicians.

The Regional Maintenance Engineers will also perform the important function of coordinating the acceptance of new hospitals and other new health facilities into the overall maintenance programs. The experiences at Coban and Cuilapa certainly support this function.

Each Regional Maintenance Repair Center Office will warehouse stocks of fast-moving spare parts and supplies.

The Central Regional Maintenance Repair Center in Guatemala City will serve also as a national bodega for essential, but not so highly used, spare parts and will repair equipment for which there is an insufficiency of trained personnel in the country, such as the repair and calibration of X-ray and sophisticated monitoring equipment, elevator, and blood gas analyzers. As training advances, this service, on the national level, will be phased out and each Regional Maintenance Repair Center will provide the services needed for its area.

To coordinate all of the MOH maintenance activities the position of Director of Health Facility Maintenance Engineering will need to be established and filled by an engineer or person with special engineering training. He will be provided with staff to assist with the auxiliary functions, but he will bear the primary responsibility for maintenance and the performance of the following duties:

a. Maintenance of facilities and equipment.

b. Logistic Support of the health maintenance services, the collection, analysis, and review of operational costs to ensure economy of operations, the adequate stocking of spare parts, the maintenance budget development, and the development of statistical information necessary for review and growth.

c. Planning of improvements, alterations, and new construction.

d. Coordination and Liaison with outside agencies, such as BID, USAID, OPS, in the area of health facilities and health engineering services.

e. Training of technical maintenance personnel in conjunction with the Training Coordinator.

f. Vehicle Repair and Maintenance, including the economic repair and maintenance of vehicles, the storage and dissemination of fuels and lubricants, and the scheduling and operation of vehicles (optional).

g. Special Projects. A staff able to perform the above functions will be capable of undertaking special functions of an engineering nature, such as: development of water resources in support of health facilities, water pollution control and solid waste handling in selected areas.

The functions of the maintenance department are depicted on Chart 1. The overall organization, including the regional maintenance centers, is shown on Chart 2. The detailed responsibilities

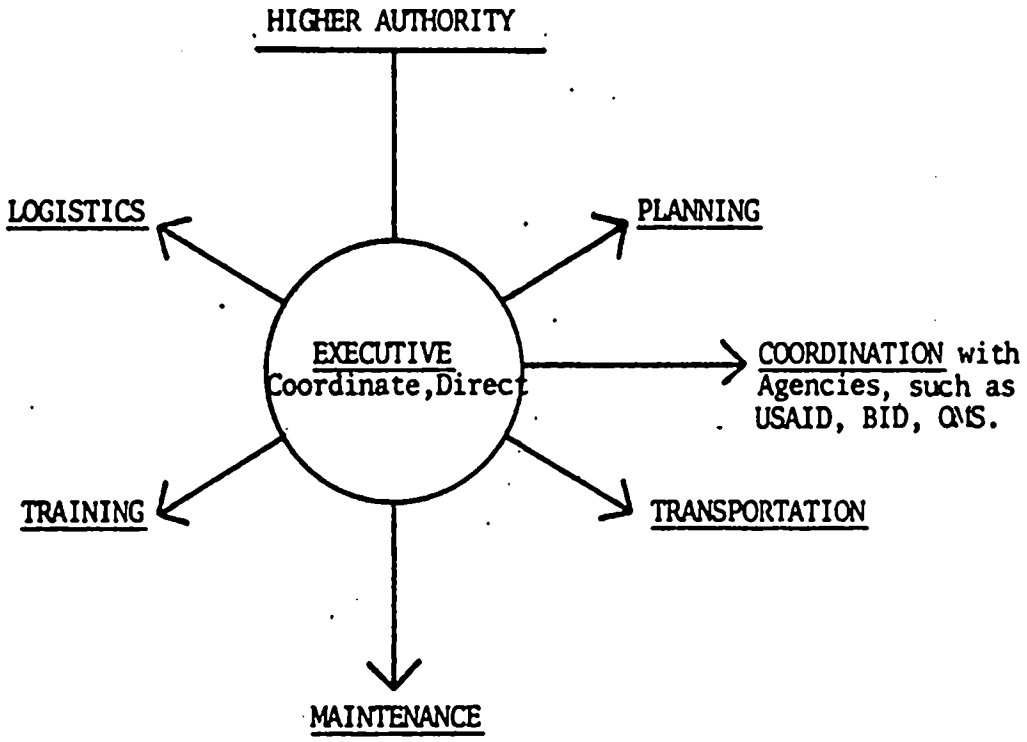
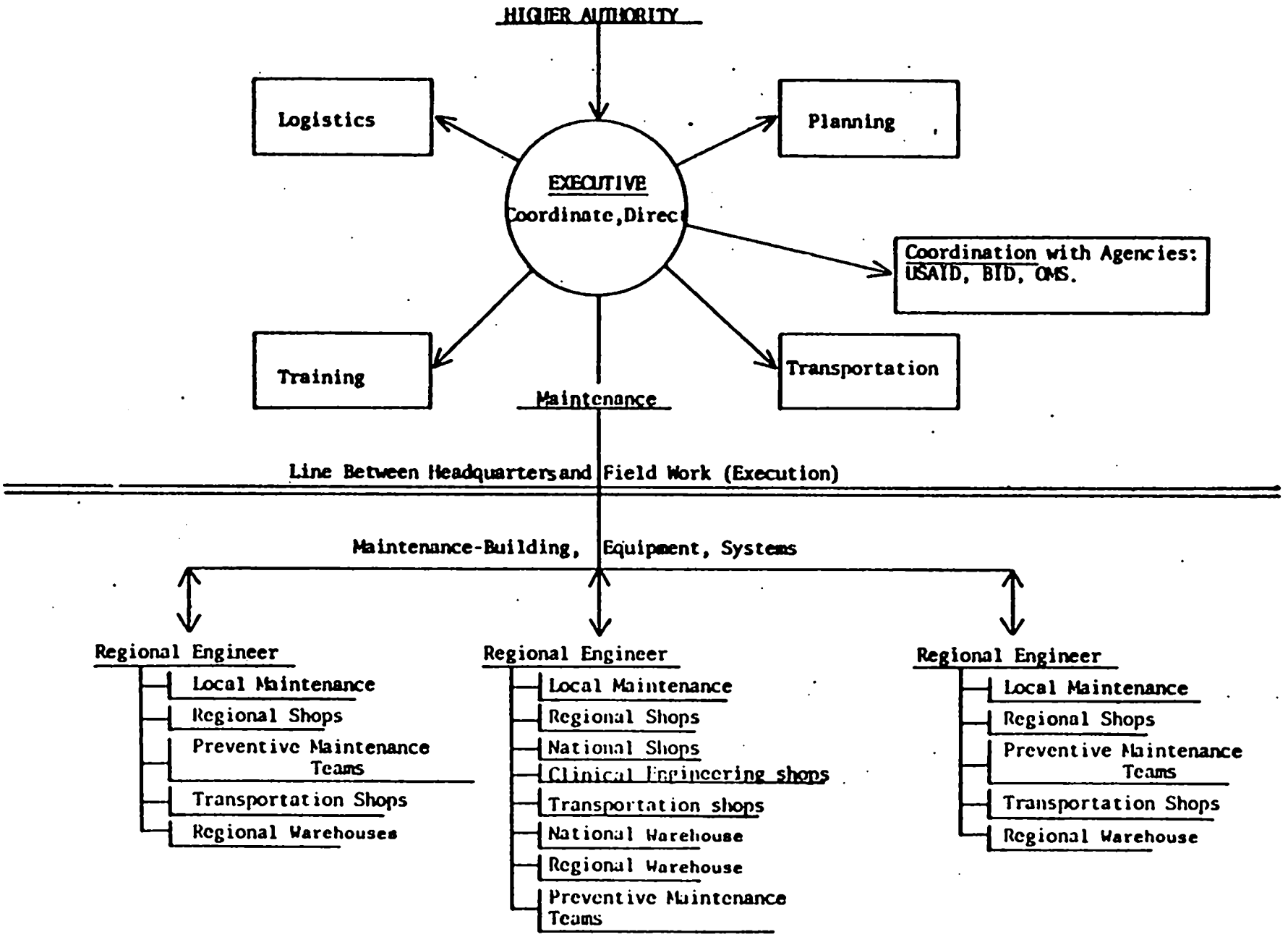


Chart 1

Functions
Maintenance Department



Functions and Primary Direction
CHART 2

→ Outward = Direction
← Inward = Staff Support

of the regional engineers and the requirements and manner of development of the local maintenance and regional maintenance programs are contained in an Augmented Report prepared for the USAID/G Division of Public Health.

It is extremely important that the central maintenance staff familiarize themselves with existing conditions and develop the national maintenance organization to meet the existing needs described. The establishment of regional and national maintenance repair shops and warehouses is recommended in this report and budget limitations are imposed but to pre-ordain regional workshop locations or personnel assignments without analysis of the actual maintenance needs of each region may lead to a situation similar to the provision of USAID equipment wherein execution preceded planning. Therefore, the organization presented and the budgetary parameters recommended are set forth as a guide to the foundation of a health facilities maintenance organization and are subject to modification as more specific information on need is acquired.

The influx of sophisticated medical equipment will expand explosively in Guatemala as the BID hospitals are completed and the older hospitals present demands for equality of medical capability. At present there are monitors at only Roosevelt Hospital and Cuilapa Hospitals; however, the advent of monitors, digital laboratory equipment, open heart surgery pumps, renal dialysis equipment, and blood gas analyzers has to be anticipated and will increase the need for a technically-competent, well-organized maintenance program within the MOH.

During the second year of the development of the maintenance organization a position should be established for a Clinical Engineer specialized in the repair of clinical instrumentation equipment, including X-ray, who will be assigned to support the health facilities maintenance program at the national level until sufficient technical personnel can be trained to provide maintenance on the regional levels.

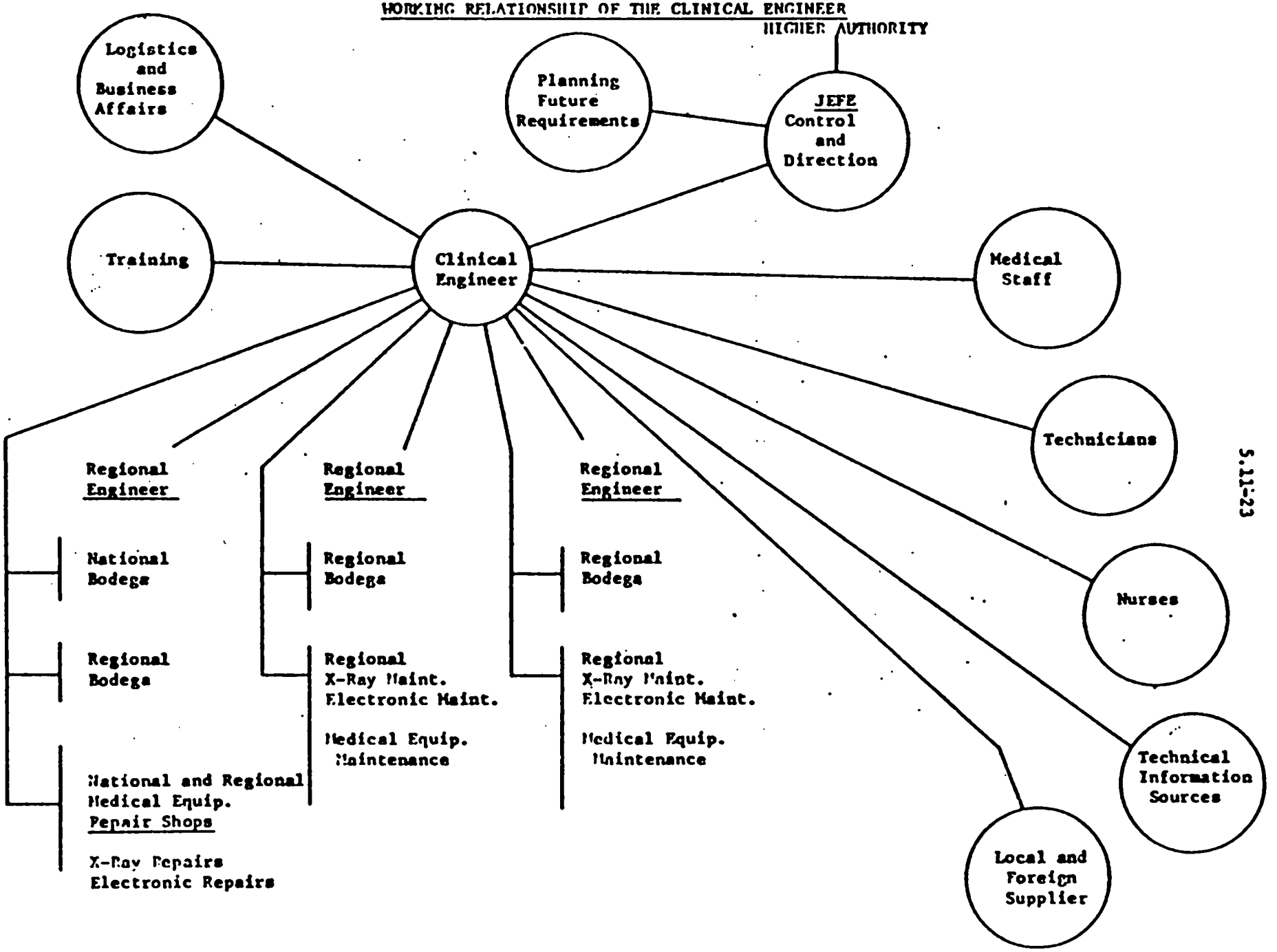
The Clinical Engineer will be responsible for the maximum availability of patient-related equipment, for advising the professional and technical staffs of the suitability of the equipment to Guatemala, for advising against unnecessary and uneconomical duplication of equipment, for suggesting methods of use to the medical staffs, and manner of use, adjustment, operation, training and operator-maintenance to the technical staff. He must report dangerous misuse of equipment to proper authorities and keep those authorities informed as to the status of equipment within their facilities.

The detailed responsibilities of the Clinical Engineer are contained in the augmented report prepared for the USAID/G Division of Public Health; a suggested equipment and tool list to establish a central clinical repair shop is attached to this report.

Chart 3 depicts the working relationship of the Clinical Engineer with the other parts of the health facilities maintenance program.

CHART 3

WORKING RELATIONSHIP OF THE CLINICAL ENGINEER



3. Development of a Short-Term Health Facilities Maintenance Training Program

The MOH in Guatemala is faced with three serious problems in staffing the health facilities maintenance forces in the country:

1. There are too few trained persons from which to select a maintenance staff for the sophisticated hospitals planned for the future.
2. The combined demand of urban industrialization and general earthquake recovery is absorbing the competent pool of manpower which is available and paying higher wages than are paid in the rural areas where much of the work needs to be done.
3. Inadequate attention is being given by the MOH to the development and training of health services maintenance personnel.

If the situation is to be alleviated a comprehensive training program for health services maintenance personnel needs to be planned without delay and implemented.

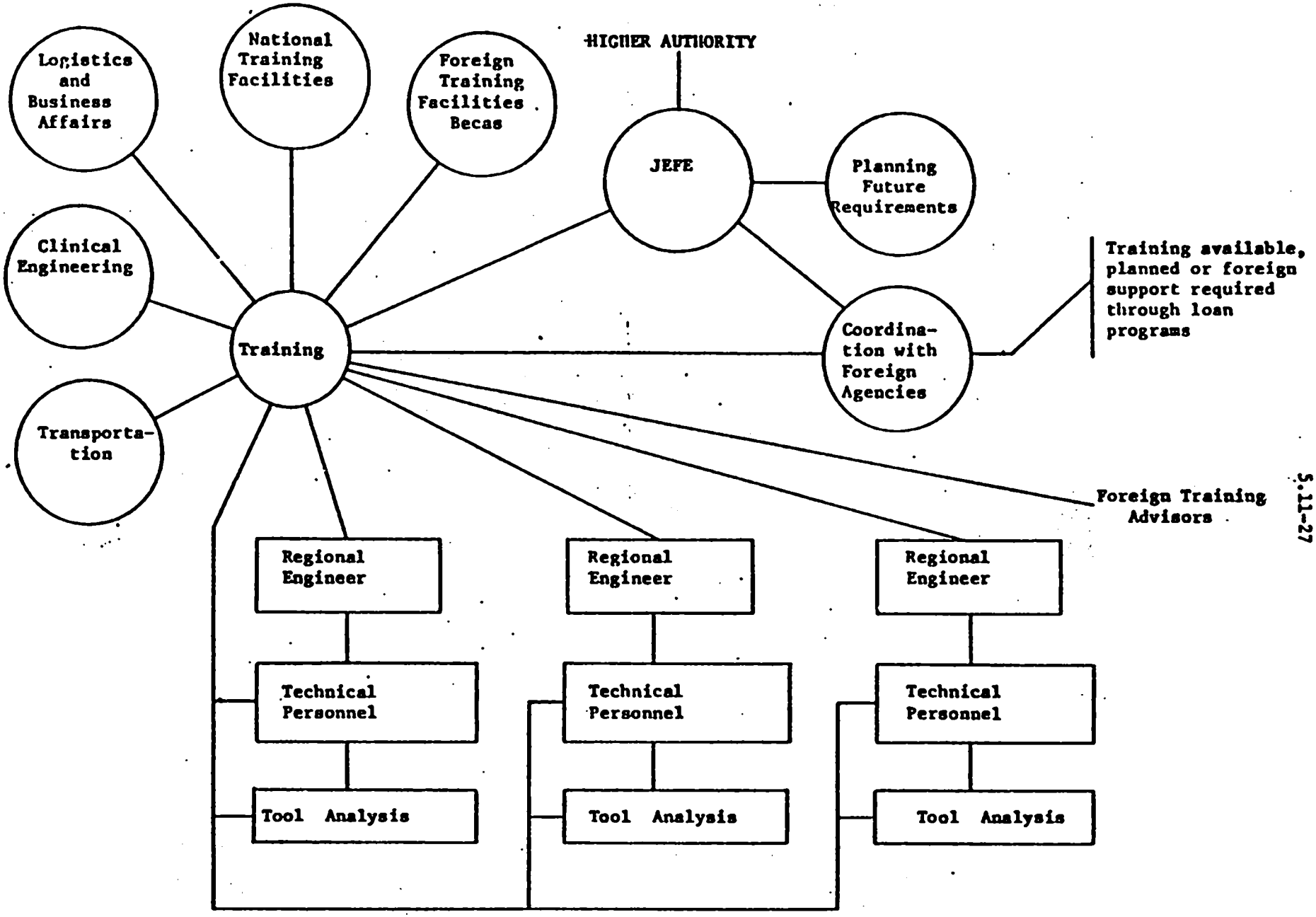
This requires establishment of a position within the MOH Maintenance Organization for a Maintenance Facilities Training Coordinator whose responsibilities are:

1. Analyze the full scope of maintenance necessary to maintain facilities and equipment.
2. Prepare job descriptions of personnel necessary to perform the work.

3. Evaluate the maintenance personnel currently working within the maintenance organization relative to the work to be performed.
4. Develop a training program to augment the maintenance capabilities of current personnel and to train new maintenance personnel.
5. Evaluate the tools and equipment available and recommend procurement of other necessary tools and equipment.
6. Arrange for personnel to be trained.
7. Develop training courses for the teachers of the maintenance program.
8. Procure training materials and training aids.
9. Select and train maintenance teachers.
10. Select students for training program.
11. Conduct a continuing evaluation of personnel under training to more fully utilize exceptional personnel and locate and limit less competent personnel.
12. Establish schedules of on-the-job training in the field and for mobile lecture and teaching programs at isolated towns and villages.
13. Establish a program of becas including criteria for receiving the becas, and evaluating and monitoring the students' progress.
14. Maintain close liaison with USAID, OMS/OPS, and BID manufacturer representatives and others who can provide becas or factory training programs.

15. Conduct inspections of operations in the field to determine that trained personnel are being utilized to the best of their ability.
16. Coordinate the use of technical assistance from outside the country in the training program.
17. Work closely with the Deputy Director for Planning in the development of maintenance plans for new facilities.
18. Translate and disseminate foreign maintenance manuals and maintenance information.
19. Issue national maintenance bulletins containing information which is of importance and timely to all maintenance facilities.
20. Advise the Health Facilities Maintenance Engineer about the individual qualifications of persons being considered for promotion.
21. Develop participation in the maintenance training program by foreign resources already in the country such as the Peace Corps and other groups.
22. Evaluate the teacher training program and modify as necessary.
23. Evaluate the maintenance personnel training program and modify as necessary.

The staff relationships necessary to fulfill the above duties are shown in diagrammatic form on the following page, Chart 4.



PARTICIPATION AND SUPPORT - TRAINING

CHART 4

Teachers and Teacher Training. Outside assistance will be necessary to:

a. Train the teachers

b. Develop the curriculum and syllabi.

Basically the program must be developed from the analysis of work to be performed which is one of the Training Coordinator's responsibilities. However, for planning purposes the health facilities maintenance training program developed for Venezuela has been used to estimate the training program needs for Guatemala. (The Venezuela program is attached as an annex to the augmented report submitted to the USAID/G Division of Public Health.)

Outside technical assistance is recommended to train both teachers and students and to assist the regional engineers in setting up the national and regional shops and in the preparation of the preventive maintenance schedules. The following list indicates the types of expertise recommended for the first year and an estimate of the length of time that will be needed:

Transportation Mechanic	2 months
Boiler Specialist	2 months
Electronic Repairman	6 months
Hospital Electrician	6 months
Hospital Plumber	6 months
Medical Equipment Repairman	6 months
Sterilizer Repairman	1 month
Warehouse Manager	2 months
Elevator Repairman	3 months
X-ray Technician or Engineer	3 months
Laundry Equipment Technician	3 months
Air Conditioning/Refrigeration Technician	3 months
Man-Month Total	43 months

An additional 43 man-months should be budgeted for the second year so that the experts can return to evaluate the success of the program and reindoctrinate or retrain personnel as necessary.

The total cost of the technical expertise will be $100,000 per year for two years, or a total of $200,000.

The classes and laboratory work will require two full-time technical school teachers assisted by two competent technicians. One of the teachers should be the head of the school. The cost of teachers and technicians will be $17,000.

Teachers should make regular visits to the outlying areas to follow up students at their work stations, to evaluate their progress, to augment the school training program, to assist in on-the-job training, and to inspect the general status of the maintenance training programs and needs in the regional repair shops. To facilitate these field visits the school should be provided with two cars (at a cost of $12,000).

The teacher will issue periodic bulletins with maintenance information of common interest to the technicians in the field, and on his field visits will be able to transmit other maintenance information and ideas, thus helping to overcome the communication void mentioned in the section on basic problems.

Curriculum. The school curriculum should include, but not be limited to, the following areas:

Janitors/minor maintenance

Laundry operations/lubrication

Kitchen maintenance

Boiler operations and maintenance

Emergency generator maintenance

Auto mechanics

Sterilization equipment maintenance

Elevator maintenance

X-ray maintenance

Medical and Lab equipment maintenance

Electronic systems maintenance

Refrigeration and air conditioning maintenance

Hospital organization

Use of tools

Shopwork

Use of maintenance manuals

Electrical training (at the need-to-know level)

The type of course work which the Venezuelan maintenance training program provides for each of these fields is included as Appendix 3 to this report.

Suggested Location of Regional Maintenance Training Schools. It is probably best not to have the school or training program in Guatemala City since a number of graduates may not go back to the outlying areas. However, the hospital at Amatitlan offers a very

good location for a Central Regional Maintenance Training School because, geographically, it is close to Guatemala City, Cuilapa and Escuintla, which offer a complete range of new and old medical equipment and facilities similar to those found throughout the country. Also, excellent space is already available for shops and classroom training in the new, but unused, boiler and laundry area, and the new boiler will be an excellent training aid.

The cost of setting up a school, less teachers' salaries, will be:

Partitions, furniture, work benches and minor alterations to the hospital space	$12,000
Tools, shop equipment and materials	6,000
Training aids, projectors, typewriters, reproduction equipment	4,000
Textbooks and teaching publications	3,000
Special electronic test and calibration equipment, plus special tools	9,000
	34,000
Probable inflation of prices	4,800
TOTAL	$38,800

The Eastern and Western Regional Maintenance Training Schools should be started only after there has been appropriate experience in the Central Region to apply in the planning and development of the new schools.

Training Materials. Training materials are available in large quantities through OPS/OMS (PAHO) and USAID.

Other countries have initiated similar training programs, and textbooks in Spanish are readily available. Both Mexico and Venezuela have excellent textbooks and will provide a copy of these to countries which are starting similar training programs.

The major manufacturers of medical equipment, boilers, laundry equipment and laboratory equipment have regional and area representatives who have full supplies of materials and training aids in Spanish. Most of these manufacturers conduct factory training programs, free of charge, for both operation technicians and maintenance technicians, and will periodically supply instructors at established schools.

In addition, the experiences in the training program at Quirigua should be evaluated and used appropriately in the planning and development of the health facilities maintenance school.

Procurement and Translation of Manuals. A program must be established to contact manufacturers and obtain maintenance and operations manuals and where appropriate, installation manuals, to be translated into Spanish for wide dissemination to the facilities personnel performing maintenance throughout the country. This program can be conducted at the school or the central headquarters. Costs are estimated at $8,000 during the first year and $4,000 the

second year. This manual procurement procedure should be initiated whether or not the training program is implemented.

Additional Training Sources. The following training sources should be investigated in conjunction with the development of the maintenance training program:

1. Peace Corps. Peace Corps' hospital maintenance programs exist in Nicaragua and El Salvador and are very successful in training persons at the hospital and health center level. If such a program were initiated, the Peace Corps would require the Government of Guatemala to provide transportation:

Two cars (4-wheel drive) (a one-time allocation)	$12,000
Gasoline per year	1,600
First Year Total	$13,600

2. Factory Training. Factory training in the U.S. is available from practically all manufacturers of health services and automotive equipment. The manufacturers require that the student be sufficiently educated to comprehend the technical training he is to receive and that the country provide transportation and subsistence during the training period.

   Factory experts are periodically sent to Guatemala during which time they can be used for short periods to conduct classes at the school and at the regional level.

3. U.S. Veterans Administration. The U.S. Veterans Administration accepts students for training in their hospitals and Clinical Maintenance School in the United States.

4. Pan American Health Organization (OMS/OPS). PAHO has much experience in the health faciilities maintenance field and in the start-up of training programs similar to the program recommended in this report. PAHO selects and fills scholarship programs for WHO and has experienced maintenance-training officers available on a contract basis.

5. Foreign Embassy. The Embassies of Germany, Spain, Japan, and other foreign countries which have expressed an interest in the assistance of developing countries should be visited to ensure that no source of training support is overlooked.

6. U.S. Military Advisory Group (MAG). If relations with MAG are renegotiated, the U.S. Army and Air Force Schools are available for the training of military and military reserve personnel at all levels of hospital maintenance training.

Probably $8,000 should be established as a planning parameter for the first year for costs of foreign training under the above agencies, excluding Peace Corps. As more basically trained technicians are developed, this dollar allocation should be increased to $10,000 each, for the second and third years.

Scholarships. Florida Institute teaches courses in Spanish on hospital maintenance and medical equipment maintenance.

It is recommended that two highschool graduates be selected and granted scholarships to this school for degree work to ensure competence in the health service maintenance field in 1980 and thereafter. The cost is estimated at $32,000.

It is further recommended that two engineers be selected for postgraduate education in the United States. To ensure the continuity of engineering services in the BID hospitals one of these engineers should have an electronics background and focus his courses toward maintenance of medical instrumentation equipment. The cost is estimated at $16,000.

There are six four-month BID maintenance becas and two architectural planning becas available, all of which are undefined and do not discuss the full measure of the training required. These becas should be used within the overall maintenance training program discussed in this report.

Life of Training School. Once a core of trained maintenance technicians is available and working, training of new personnel can be done on-the-job in each of the regional repair centers or the larger hospital facilities. Therefore, any school or training program developed for the purpose of training a core of maintenance personnel will have served its purpose after five years and should be discontinued.

B. ALTERNATIVES TO THE ESTABLISHMENT OF AN MOH HEALTH FACILITIES MAINTENANCE AND TRAINING PROGRAM.

If the maintenance and training functions cannot be initiated as discussed in the previous section, alternatives are: maintenance through contracts, and training through INTECAP. These are discussed below:

1. Contract Maintenance. A form of contract maintenance is currently being used by the MOH, unsuccessfully. To be effective both parties to the contracts must be knowledgeable about the equipment and facilities under contract. However, maintenance is performed now through a vendor-consumer relationship in which the vendors are knowledgeable and the consumer (MOH) has little understanding of the technical know-how required for the maintenance function. Even with a contract maintenance program an MOH engineering maintenance staff, familiar with the scope and characteristics of the work to be performed, is required to ensure that the MOH receives the total services for which money is paid to the contractors. Currently, there is no such engineering staff within the MOH. The cost for its development must be considered a cost within a contract maintenance program and will roughly equal the cost for the maintenance program previously recommended.

Prior to signing a maintenance program contract, a contractor requires that all equipment be placed in good operating condition. Using X-ray equipment as an example, maintenance

by vendors is now being used, and the equipment outside of Guatemala City is currently in very poor condition. In many cases vendors have not visited the equipment for eight months to a year; at Puerto Barrios the X-ray power cable has been burned out more than eight years. It would be very difficult to place the X-ray equipment in condition for contract work.

Additionally, the X-ray equipment in MOH facilities is manufactured by at least eight separate companies. Therefore, eight separate maintenance contracts are required for X-ray maintenance alone. Multiple contracts are also required for boilers since the boilers in use are manufactured by at least six different companies. Huehuetenango and Roosevelt Hospitals each have two boilers of different manufacture and would require duplicate boiler maintenance contracts. In the case of Huehuetenango double travel time would be necessary for boiler repair by contract.

Contract maintenance can essentially be categorized as "breakdown" maintenance, especially in the rural areas. There is such a large volume of equipment in the private clinics and laboratories and the public and private hospitals in Guatemala City that the few technically trained technicians which do exist are rarely sent outside of the city.

At present, the rural areas send small items of equipment to INDAPS for repair. However, any job which exceeds the repair capability of INDAPS is sent elsewhere by them and a hospital

or center may see a "down time" of equipment exceeding eight months. INDAPS states that their entire year's budget is spent on paying last year's bills so equipment with problems this year cannot be promptly repaired.

The maintenance of large items of equipment is ignored due to lack of funds. For example, the large Castle sterilizer at Huehuetenango is out of commission because it has a bad gasket. The cost of sending a Castle Company man to the hospital is prohibitive. The gasket costs about $3.00. The engineer has no manual, no spare parts identification list and no money, so the repair is not made.

To conduct a full contract maintenance program in the health facilities of Guatemala would require an estimated initial outlay of about $13 million in order to put the existing equipment in operating condition. And still, an engineering and maintenance staff within the MOH would be required to ensure that the contracts cover all work to be done and are executed to the benefit of the Ministry.

Therefore, it is recommended that all maintenance services <u>not</u> be contracted for the following reasons:

1. High costs.
2. Historical lack of response.
3. No general improvement of facilities would result because contract maintenance is usually oriented to breakdowns.

4. The MOH currently lacks the technical capacity to adequately monitor the contracts.

5. This approach fails to develop a maintenance infrastructure within the MOH.

However, if this alternative is to be given further consideration, two issues must be addressed. First, the engineering capacity of the MOH must be increased to monitor and direct contractors. Second, the contract terms must include regular, preventative maintenance as well as repair when the equipment breaks down.

2. INTECAP Training. INTECAP has broad technical training functions under the Ministry of Labor and currently has approximately 3,000 students under instruction at its Technical School in Guatemala City. INTECAP graduates are in demand, and the average salary upon graduation is $250 per month.

Only one course is taught with hospital maintenance in mind but it is known that INTECAP is willing to undertake a national hospital training program. The present program requires attendance for three years and this lengthy program would have to be shortened and modified to be suitable for the maintenance needs of the health facilities.

The role of the Ministry of Labor in the overall technical training of manpower should not be duplicated by the MOH by teaching the basic subjects at a hospital technical maintenance training school which require years of teacher training. It

would serve the MOH better if the INTECAP Technical School graduates could attend the hospital technical maintenance training courses to focus on hospital maintenance, or could attend the classes at Quirigua to become hospital technicians.

The fact that the INTECAP Technical School is in Guatemala City is a drawback for, if young men with manual dexterity are brought from the outlying areas and trained, they may not return. Training sites outside of the city would have to be developed.

In summary, therefore, by contracting the hospital technician training program with INTECAP the following benefits will be derived:

a. The teaching program could take advantage of the four years of successful experience that INTECAP has had in technical education.

b. Courses can be established and discontinued in response to the needs of the hospital maintenance program without duplicating existing training staff or facilties.

c. The maintenance-teaching program will be more flexible as the training will be part of a larger training program.

d. A pool of teachers is available from the other technical areas being taught at INTECAP.

C. ALTERNATIVE: TRANSFER OF MAINTENANCE AND TRAINING FUNCTIONS TO THE MINISTRY OF LABOR.

Another alternative solution is to contract with INTECAP for both the training of technical maintenance personnel and for the maintenance of health facilities and equipment.

The basis for the alternative is:

a. INTECAP already has schools to train technicians.

b. A substantial part of maintenance training is best done in the environment in which actual maintenance is being done. Since INTECAP has the technical capacity for training and service, it is logical that they be considered for providing both services.

This suggestion implies that MOH is responsible for health care but INTECAP would be responsible for the facilities and equipment through which health care is provided.

The owner (MOH) of the health facilities and, in fact, the owner of any facility, cannot divorce himself from the maintenance of his facilities. Maintenance is a service function inherent in ownership. The failure of buildings and machinery is usually preceded by a warning of the failure. However, regular inspection and observation of equipment, and communication with operational personnel is essential in order to detect signs of deteriorations early and take preventive or corrective measures. To assign this service function to a third party assumes that the MOH has the technical capacity to adequately monitor the contractor.

Under this arrangement, it is possible that INTECAP would need to be consulted about future MOH health programs in order to determine if the plans and programs are feasible from a maintenance point of view.

IV. A. RECOMMENDATIONS

1. That a hospital engineer be employed within USAID/G to assist the GOG with program development.

2. That a Hospital Maintenance Program and Maintenance Technical Training School be established, either within the MOH or under contract and that regardless of how the services are provided, the MOH must develop technical capacity to plan, administer and monitor all aspects of the program.

3. That financial assistance be provided to the MOH to overcome the initial costs of establishing and equipping the Hospital Maintenance Program, including the Regional Repair shops.

4. That financial assistance be provided in the establishment of a Maintenance Technician Training School.

5. That foreign technical expertise be provided during the formation of a Hospital Maintenance Organization and Training Program and for revisits to evaluate the program and reindoctrinate the staff.

6. That a system of tool inventory control and distribution be set up to prevent theft.

7. That a program be initiated to obtain, translate to Spanish, and disseminate maintenance manuals to MOH sites.

8. That a scholarship program be provided over the next three years for long-term institutional training and short-term training through factory training programs.

9. That a Peace Corps Volunteer Program be instituted in hospital engineering.

IV. B. ESTIMATED COST EFFECTIVENESS OF THE PROPOSED PROGRAMS

The total annual expenditures of the GOG are approximately $400 million. Of the $39 million (or 9%) allocated to the MOH in 1976, the following amounts were allocated to health facilities and equipment maintenance:

Headquarters	$108,352	
Metropolitan Region	152,442	
Outlying Regions	124,873	$385,667
Transportation Center		155,810
TOTAL		$541,477*

There are approximately 37 hospitals, 159 health centers and 470 health posts in Guatemala. Only token funds are allocated for the maintenance of these health facilities. Of the $39 million MOH budget, $152,442 is spent on the 9 hospitals, 29 health centers and 50 health posts in the Capital; $124,873 is spent in maintenance support in the outlying regions of the country. Excluding costs for maintenance personnel at Roosevelt Hospital, the largest hospital in the country, $50 is allocated for maintenance of buildings and $3,000 for maintenance of medical equipment. Twenty hospitals are assigned no funds for building maintenance and seven are assigned $200 or less.

To be realistic, the funds for minimal effective maintenance of all the MOH facilities and equipment should approach $15.0 million or 5% of the investment in facilities and equipment.

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* See Appendices 1(a) through (1) and 2(a) and (b) for details of 1976 MOH maintenance expenditures.

1. Discussion of Major Recommendations. A recommendation is made to develop within the MOH an engineering group, familiar with the condition of the facilities and equipment, which can advise the Ministry of Health of the actual maintenance costs necessary to maintain facilities and equipment in good operating condition.

Not only are the present expenditures not providing adequate maintenance support but the approximately $300 million currently invested in facilities and equipment will be lost within the forseeable future without a program of regular and competent maintenance.

The recommendation that a responsible and competent health facilities and maintenance organization be developed to implement maintenance programs on a regional basis will require an influx of tools, spare parts and maintenance supplies as well as a centralized staff and appropriate technical staff in each of the hospital facilities.

For administrative and operational staff plus logistical support, the total annual cost for this proposed program is estimated at $10,635,900. Additionally, an estimated $13 million more will be needed to bring the facilities and equipment up to a level at which they can be well maintained by the recommended maintenance staff. This will permit the installation and operation of unused equipment provided by MOH and USAID/G and will allow the hospitals to function more effectively. In addition, the IDB program will benefit by well-coordinated maintenance programs to support the hospitals to be built.

A recommendation is made to overcome the shortage of technical personnel specifically trained in hospital maintenance by initiating a short-term $410,000 training program which includes $200,000 for technical experts and which will provide an immediate hospital maintenance work force This short-range goal can be adequately met within five years and at the end of this period the school should be closed. At this point, other national training programs, plus apprentice programs in the Regional Maintenance Repair Shops, will be able to meet the maintenance personnel training needs. An effective training program will reduce reliance on contractor and vendor maintenance and repair which will cost approximately $15 million annually if used to rehabilitate facilities and equipment and to maintain current and future facilities.

The recommendation to employ a competent hospital maintenance engineer within USAID/G to advise in the development of the maintenance program will result in significant savings. This engineer will cost approximately $36,000 annually for base salary and support costs but should ensure that the program is conducted in a progressively efficient manner.

The estimated annual costs to the Ministry of Health for the proposed maintenance service program are:

1.	Centralized Maintenance Organization	$ 134,000
2.	Regional Maintenance Administration and Organization	1,501,900
3.	Hospital Maintenance Staff and Logistical Support	9,000,000
	Estimated Costs - Subtotal	$10,635,900

In addition the first-year startup costs are estimated for:

4.	Maintenance Technical Training Program	215,000
	Total Estimated Costs	$10,850,900

1. COSTS TO DEVELOP A CENTRALIZED MAINTENANCE ORGANIZATION

Executive and Staff functions as shown on Chart 1

Salaries

Director	$ 14,000
Logistics	12,000
Transportation	12,000
Planning and coordination (combined)**	12,000
Training	12,000
Maintenance (performed by Director)	
Clinical Staff: (3 clerks, 1 accountant, 3 secretaries, 2 draftsmen, 1 receptionist, 1 janitor, 1 office boy	33,000
	95,000
10% Inflation factor	9,500
SUB-TOTAL	$ 104,500

Other Costs

Office equipment and furniture	22,000
Office supplies	4,500
Temporary building*	14,000
Transportation:	
3 trucks x $6,000	18,000
Gas, oil, maintenance	6,000
SUB-TOTAL	$ 64,500
TOTAL	169,000
1976 MOH Budget for Central Maintenance	- 35,000
NEW COST TO MOH	$ 134,000

Notes:

* The permanent headquarters should be planned for inclusion in a BID hospital to be constructed in Guatemala City.

** During the second year the office of coordination should be separated from planning to increase the effectiveness in both functional areas; added cost for second year will be $14,500.

2. COSTS TO DEVELOP A REGIONALIZED MAINTENANCE ORGANIZATION

Maintenance and Logistic Function as shown on Chart 2

Central Region:

Salaries

Engineer	$ 12,500	
Clinical Engineer	12,000	
Local Maintenance	94,329	
Regional Shops (17 men x $ 5,000)	85,000	
National Shops (3 men x $ 9,000)	27,000	
Transportation Shop	35,000	
National Bodega/Regional Bodega (combined)	9,000	
Preventive Maintenance, 3 teams	18,000	
Clerical Staff: 2 Secretaries, 2 clerks, draftsman, janitor	8,000	
SUB-TOTAL	300,829	
10% Inflation factor	30,000	
	$ 330,829	
Less present salaries	- 76,327	
TOTAL NEW COSTS - Salaries		$254,500

Other Costs:

Tools for isolated posts	2,000	
Tools for Health Centers	5,000	
Tools for Central Region Shop*	20,000	
Office, Shop and Bodega equipment and furniture	6,000	
Supplies	4,500	
Spare Parts	30,000	
Outside Repairs	30,000	
Per Diem**	12,000	
Temporary building***	14,000	
Transportation		
11 trucks	66,000	
Gas, oil, maintenance**	26,500	
Installation of USAID and MOH equipment	60,000	
Local maintenance - initial stock supplies	12,000	
TOTAL NEW COSTS - Non-salary		$ 288,000
TOTAL - New Costs for Central Region		$ 542,500

* To be augmented during second and third years based upon need developed through experience - parameter $ 12,000.

** Each recurs during 2nd and 3rd years, making a total of $38,500 annually.

*** Permanent building should be included in a BID hospital when built.

Eastern and Western Regions: (Figures are calculated for one Region and doubled in the final total.)

Salaries

Engineer	$ 12,000	
Local Maintenance	35,787	
Regional Shops (12 x $5,500)	66,000	
Transportation Shop (6 x $4,000)	24,000	
Regional Bodega (2 x $4,000)	8,000	
Preventive Maintenance Teams (3 teams)	18,000	
Clerical Staff: 2 Secretaries, 2 clerks, draftsman, janitor	8,000	
Total	171,787	
10% Inflation Factor	17,000	
Total Salaries Required	188,787	
Less Present Salaries	-27,787	
TOTAL NEW SALARY COSTS		$161,000

Other Costs

Tools for isolated posts	2,000	
Tools for Health Centers	6,000	
Tools for Regional Shops*	10,000	
Office, Shop and Bodega furniture and equipment	6,000	
Supplies	4,500	
Spare Parts	15,000	
Outside Repairs	8,000	
Per Diem**	10,000	
Temporary Building***		
Transportation		
9 trucks	54,000	
gas, oil, maintenance**	16,000	
Installation of USAID and MOH equipment	80,000	
Local Maintenance		
Initial stocks of supplies	12,000	
TOTAL NEW COSTS - Non-salary		$223,500
TOTAL NEW COSTS - Eastern Region		384,500
TOTAL NEW COSTS - Western Region		384,500

TOTAL COSTS FOR CENTRALIZED MAINTENANCE ORGANIZATION AND REGIONAL MAINTENANCE ORGANIZATIONS EXCLUDING PERSONNEL AUGMENTATIONS

Headquarters	$134,000	
Central Region	542,500	
Western Region	384,500	
Eastern Region	384,500	
GRAND TOTAL		$1,445,500

* To be augmented during second and third years, for additional tools and equipment, based upon the needs which develop through experience and improved technical competence - parameter $14,000.

** Each recurs during second and third years, making a total of $26,000 annually.

*** Permanent regional shops should be incorporated in a large BID hospital to be built in the area.

2. a. ADDITIONAL MAINTENANCE PERSONNEL NEEDED IN HEALTH FACILITIES TO PROVIDE MAINTENANCE SERVICES

BY REGION

Metropolitan Region - augmentation required - 4 men x $1,200 each $ 4,800

1 each at the two hospitals with no maintenance staff.
2 to visit Health Centers and dispensaries for minor repairs. Travel by bus.

Region I - augmentation required - 11 men x $1,200 $13,200

Location	Staff Required	% of Time
Hospital Elisa Martinez	1	100%
Health Center Antigua Guatemala	1	50%
Hogar Rodrigo	1	50%
Health Center Sacatepéquez	1	33%
Health Center Chimaltenango	1	50%
Health Center Jilotepeque	1	33%
Health Center Tecpán	1	33%
Health Center Amatitlán	1	33%
Health Center Villa Nueva	1	33%
Health Center Palín	1	33%
Health Center Escuintla	1	50%
Health Center Cotzumalguapa	1	33%
Health Center La Democracia	1	33%
Health Center San José	1	33%
Health Center Taxisco	1	33%

Region II - augmentation required - 7 men x $1,200 $ 8,400

Location	Staff Required	% of Time
Health Center Zacapa	1	100%
Health Center Gualán	1	33%
Health Center Cabañas, Zacapa	1	33%
Health Center Teculután	1	33%
Health Center Río Hondo	1	33%
Health Center El Progreso	1	100%
Health Center Acasaguastlán	1	33%
Health Center Sanarate	1	33%
Health Center Jocotán	1	33%
Health Center Chiquimula	1	33%
Health Center Quezaltepeque	1	33%
Health Center Esquipulas	1	33%
Health Center Puerto Barrios	1	33%
Health Center Santo Tomás	1	33%
Health Center Livingston	1	33%
Health Center Estor	1	33%
Health Center Amates	1	33%
Health Center Navajoa	1	33%
Health Center Izabal	1	33%

Region III - augmentation required - 5 men x $1,200 $ 6,000

Location	Staff Required	% of Time
Health Center Jutiapa	1	100%
Health Center Santa Catarina Mita	1	33%
Health Center Asunción Mita	1	33%
Health Center Moyuta	1	33%
Health Center Jalapa	1	33%
Health Center Mataquescuintla	1	33%
Health Center Cuilapa	1	50%
Health Center Nueva Santa Rosa	1	33%
Health Center Barberena	1	33%
Health Center Chiquimulilla	1	33%

Region IV - augmentation required - 4 men x $1,200 $ 4,800

Location	Staff Required	% of Time
Health Center Mazatenango	1	100%
Health Center Chicacao	1	33%
Health Center Patulul	1	33%
Health Center Río Bravo	1	33%
Health Center Suchitepéquez	1	33%
Health Center Tiquisate	1	33%
Health Center Concepción	1	33%
Health Center Champerico	1	33%
Health Center Coatepeque	1	33%
Health Center Tecún Umán	1	33%
Health Center Malacatán	1	100%
Health Center Tumbador	1	33%

Region V - augmentation required - 9 men x $1,200 $10,800

Location	Staff Required	% of Time
Hospital Clínica Tórax	1	33%
Health Center Quetzaltenango	1	100%
Health Center Palestina	1	33%
Health Center Totonicapán	1	100%
Health Center Momostenango	1	33%
Health Center Sololá	1	100%
Health Center Panajachel	1	50%
Health Center Santa Cruz Quiché	1	50%
Health Center Chichicastenango	1	50%
Health Center Uspantán	1	33%
Health Center Joyabaj	1	33%
Health Center Nebaj	1	33%
Health Center Huehuetenango	1	100%
Health Center San Pedro Soloma	1	33%
Health Center San Antonio Huista	1	33%
Health Center San Pedro Necta	1	33%
Health Center San Marcos	1	100%
Health Center Comitancillo	1	33%
Health Center Tejutla	1	33%
Health Center Tacaná	1	33%
Health Center La Reforma	1	33%
Health Center San Pablo	1	33%

Region VI - augmentation required - 4 men x $1,200 $ 4,800

Location	Staff Required	% of Time
Health Center Cobán	1	100%
Health Center Tucurú	1	33%
Health Center Carchá	1	50%
Health Center Cahabón	1	33%
Health Center Senahú	1	33%
Health Center Salamá	1	100%
Health Center Rabinal	1	50%
Health Center Cubulco	1	50%

Region VII - augmentation required - 3 men x $1,200 $ 3,600

Location	Staff Required	% of Time
Health Center Petén	1	100%
Health Center Poptún	1	100%
Health Center Sayaxché	1	50%
Health Center San Luis Petén	1	33%

TOTAL AUGMENTATION - 47 persons x $1,200 $56,400

3. TECHNICAL STAFF REQUIRED FOR MAINTENANCE OF MOH HOSPITALS

	SKILL LEVEL		
	Basic Level	Mid Level	Advanced Level
Health Facility Engineers	4	4	3
Clinical Engineers	4	4	3
Electrical Technicians	30	21	34
Electrical/Medical Technicians	25	34	12
Refrigeration/Air Conditioning Technicians	48	34	11
Mechanical Technicians	48	34	11
Plumbers	48	48	22
Carpenters	48	34	22
Painters	48	34	11
Auto Mechanics	48	44	34
Masons	48	34	11
Boiler Technicians	48	34	11
Metalworkers (Welders)	25	34	34
X-ray Technicians	48	48	11
Building Maintenance Supervisors	25	34	11
Supply Technicians	48	34	11

The total technical staff needed based on the above estimate is 1,354 virtually all would be new positions.

Estimated annual salary cost for this staff is $4,500,000. Logistical support, such as tools, space, and spare parts, is projected at an additional $4,500,000. Total recurrent annual cost for staff and support is $9,000,000.

Source: John Donahue, PAHO Engineer, August 1977.

4. MAINTENANCE TECHNICAL TRAINING PROGRAM

	PROGRAM YEAR 1	2	3	TOTAL
Establishment of Maintenance Training School	38,800	3,500*		42,300
Salary for Training School Teachers	17,000	17,000	17,000	51,000
Provision of foreign experts for technical training, regional assistance and evaluation	100,000	100,000		200,000
Program to obtain maintenance manuals, translate these manuals to Spanish and disseminate the manuals to equipment locations	8,000	4,000		12,000
Long range education: two Degree-oriented courses; two graduate courses	16,000	16,000	16,000*	48,000
Factory and other foreign technical training	8,000	8,000	8,000	24,000
On the job traing				33,600
a. Mobility of training school teachers - 2 trucks plus annual gas and maintenance of $ 1,600	13,600	1,600	1,600	
b. Peace Corp - 2 cars ($12,000) plus annual gas and maintenance	13,600	1,600	1,600	
TOTAL COSTS	215,000	151,700	44,200	410,900 **

* Use of funds may extend to the next year

** Total does not include room and board stipend for students while attending the Training Program in Guatemala.

APPENDICES

1. MOH Maintenance Budgets for 1976 by Region
2. MOH Transportation Maintenance Budget and Distribution of MOH Vehicles
3. Maintenance Technical Training Program Developed for Hospitals and Health Centers in Venezuela
4. Suggested Tool Requirements for:
   (a) National Clinical Engineering Workshop
   (b) Regional Maintenance Workshop
   (c) Local Health Facilities
5. U.S. Army Standards for Equipping Hospital Workshops

TOTAL MOH MAINTENANCE BUDGET-1976

Headquarters (see below)	264,162
Metropolitan Region	152,442
Region I	16,107
Region II	24,478
Region III	17,055
Region IV	18,406
Region V	33,323
Region VI	9,354
Region VII	6,150
TOTAL MAINTENANCE BUDGET	$541,477

MAINTENANCE OF MOH HEADQUARTERS & STAFF

Repair of Office Equipment		11,110
Repair of Medical Equipment		13,600
Contract Maintenance		11,102
Maint. of Buildings		4,700
Tools		1,130
General Spare Parts		5,500
Repair of Education Equipment		550
Repair of Comm. Equipment		5,200
Public Health Training Center		43,200
Hospital Mechanics (24)	31,680	
Maintenance Workers(12)	11,520	
General Maintenance Department		10,940
Engineer (1)	6,300	
Equipment Mechanic (1)	1,700	
Shop Personnel (2)	2,940	
Cemetaries		1,320
1 mechanic	1,320	
SUB-TOTAL		$ 108,352
Transportation Maintenance Budget (See Appendix 2 (a))		155,810*
TOTAL HEADQUARTERS MAINTENANCE BUDGET		$ 264,162

* This item increased to 251,250 in 1977, less gasoline.

MOH MAINTENANCE BUDGET-1976 BY REGION

HEALTH REGION	MAINTENANCE ALLOCATIONS - NON SALARY FUNDS										SALARY ALLOCATIONS		
Health Facility	Office Equip.	Medical Equip.	Buildings & Install.	Contract Maint.	Comm. Equip.	Trans. Equip.	Educ. & Rec.Equip.	Tools	Spare Parts Transp.	Spare Parts Machinery	Maint. Personnel Numbers	Maint. Salaries Annual	Total Salaries in facility Annual
METROPOLITAN REGION													
Roosevelt	1,000	3,000	50	1,000	2,500	3,500	200		1,000		43	48,540	1,771,092
San Juan de Dios	3,500	2,000		1,200	800	600	100	361	1,500	3,000	32	36,560	1,927,296
Children's Hospital Preschool	95												59,964
Children's Hospital María Teresa	125	200	195										90,468
Hospital St. Vincent	420	500	2,000	200	250	500	120	500	300		11	12,360	393,228
Children's Rehabilitation Polio	180	180	640			180					2	2,280	153,636
Hosp. Neuro Psychiatric	300	400				300					3	3,600	388,260
Recup. Center (Lisiados)	100	500	656								6	4,800	178,869
TB Hospital	250	750	350										
Phychiatric Hospital	400		1,700			200					3	3,120	130,644
Total (10 Hospitals)	6,370	7,530	5,591	2,400	3,550	5,280	420	861	2,800	3,000	110	111,260	5,093,457
11 Health Centros	550	250	550		50	100	200		500				309,654
2 Health Posts													
2 Mobile Units													
2 Dispensaries (TB)	180	180	640			180							86,052
	7,100	7,960	6,781	2,400	3,600	5,560	620	861	3,300	3,000			

TOTAL MAINTENANCE

Pers.	111,260
Non Pers.	41,182
	$152,442

Total Hospital base payroll	5,093,457
Total Hospital maintenance payroll	111,260
Maintenance = 2% of overall salary	

MOH MAINTENANCE BUDGET-1976 BY REGION

HEALTH REGION	MAINTENANCE ALLOCATIONS - NON SALARY FUNDS										SALARY ALLOCATIONS		
Health Facility	Office Equip.	Medical Equip.	Buildings & Install.	Contract Maint.	Comm. Equip.	Trans. Equip.	Educ. & Rec.Equip.	Tools	Spare Parts Transp.	Spare Parts Machinery	Maint. Personnel Numbers	Maint. Salaries Annual	Total Salaries in facility Annual
REGION I													
Hospital Bethancourt	100	360	360			610			284		2	1920	141,922
Hospital Elisa Martínez	100	80				100			120		0	0	59,100
Hogar Rodrigo	25		240								0	0	30,000
Hospital Amatitlán	117	62				10			300		2	2880	154,056
Hospital Childrens, Amatitlán	114	60				160				180	2	2280	106,704
Hospital Escuintla	30	1000									1	1720	45,336
6 Hospitals	486	1562	600	0	0	880	0	0	704	180	7	9400	537,118
13 Health Centers	715	470	960	0	0	30	0	0	120	0	0	0	37,101
56 Health Posts	0	0	0	0	0	0	0	0	0	0			
2 Mobile Unit	0	0	0	0	0	0	0	0	0	0			
	1201	2032	1560	0	0	910	0	0	824	180			

TOTAL MAINTENANCE

Pers.	$ 9,400
Non Pers.	6,707
Total	$ 16,107

Total hospital budgeted base payroll = 537,118

Total hospital maintenance payroll (budgeted) = 8,800

Maintenance personnel = 1.7% of overall salary

MOH MAINTENANCE BUDGET-1976 BY REGION

HEALTH REGION	MAINTENANCE ALLOCATIONS - NON SALARY FUNDS										SALARY ALLOCATIONS		
Health Facility	Office Equip.	Medical Equip.	Buildings & Install.	Contract Maint.	Comm. Equip.	Trans. Equip.	Educ. & Rec.Equip.	Tools	Spare Parts Transp.	Spare Parts Machinery	Maint. Personnel Numbers	Maint. Salaries Annual	Total Salaries in facility Annual
REGION II													
Hosp. Zacapa	80	240							200		6	6,780	179,640
Hosp. Puerto Barrios	120		700			200					2	2,880	91,308
Hosp. Chiquimula*	354	100	501	500	500		150		720		3	3,960	151,872
Child. Hosp. Puerto Barrios	120					200			175		2	2,880	102,312
Total 4 Hospitals	674	340	1,201	500	500	400	150		1,095		13	16,500	525.132
20 Health Centers	790	790	1,280			198		40	20				514,009
29 Health Posts													
4 Mobile Units													
	1,464	1,130	2,481	500	500	598	150	40	1,115				

TOTAL MAINTENANCE

Pers.	$ 16,500
Non Pers.	7,978
	$ 24,478

Total Hospital budgeted payroll 525,132
Total Maintenance payroll (budgeted) 16,500
Maintenance personnel = 3.1% of overall salary

*Hosp. Chiquimula has $300 for city work.

MOH MAINTENANCE BUDGET-1976 BY REGION

HEALTH REGION	MAINTENANCE ALLOCATIONS - NON SALARY FUNDS										SALARY ALLOCATIONS		
Health Facility	Office Equip.	Medical Equip.	Buildings & Install.	Contract Maint.	Comm. Equip.	Trans. Equip.	Educ. & Rec.Equip.	Tools	Spare Parts Transp.	Spare Parts Machinery	Maint. Personnel Numbers	Maint. Salaries Annual	Total Salaries in facility Annual
REGION III													
Headquarters	200								120				
Hospital Jutiapa	200	0	0	0	0	0	0	0	120	90	3	2880	131,160
Hospital Jalapa	50	100	0	0	0	0	0	25	150	0	2	3120	103,956
Hospital Cuilapa	700	800	4000	0	400	0			0	300	2	2880	141,042
Total 3 Hospitals	1150	900	4000	0	400	0	0	25	390	390	7	8880	376,158
Total 11 Health Centers	560	90	130	0	0	140	0	0	0	0			
Total 49 Health Posts	0	0	0	0	0	0	0	0	0	0			
Total 2 Mobile Units	0	0	0	0	0	0	0	0	0	0			
	1710	990	4130	0	400	140		25	390	390			

TOTAL MAINTENANCE

Pers.	$ 8,880
Non. Pers.	8,175
Total	$ 17,055

Total Hospital Budgeted Salaries = 376,158
Total Maintenance Salaries (Budgeted) = 8,880
Maintenance personnel = 2.1% of total salaries

MOH MAINTENANCE BUDGET-1976 BY REGION

HEALTH REGION	MAINTENANCE ALLOCATIONS - NON SALARY FUNDS										SALARY ALLOCATIONS.....		
Health Facility	Office Equip.	Medical Equip.	Buildings & Install.	Contract Maint.	Comm. Equip.	Trans. Equip.	Educ. & Rec.Equip.	Tools	Spare Parts Transp.	Spare Parts Machinery	Maint. Personnel Numbers	Maint. Salaries Annual	Total Salaries in facility Annual
REGION IV													
Hospital Mazatenango	100	0	0	0	0	305	0	0	100	0	4	5100	126,036
Hospital Tiquisate	100	200	200	50		100		100	60	100	2	2880	119,268
Hospital Retalhuleu	0	200	460	100		250		100	300		2	2880	126,648
Hospital Coatepeque	100	200	100	300	20	250					2	1980	122,676
4 Hospitals	300	600	760	450	20	905	0	200	460	100	10	12840	494,628
Headquarters	50					120							
13 Health Centers	538	453	610	0	0	0	0	0	0	0	0	0	344,128
59 Health Posts	0	0	0	0	0	0	0	0	0	0			
Totals	888	1053	1370	450	20	1025		200	460	100			

TOTAL MAINTENANCE

Pers.	$ 12,840
Non Pers.	5,566
	$ 18,406

Total Budgeted Hospital Salaries = 494,628
Total Salaries of Maintenance force (budgeted) = 12,840
Maintenance personnel = 2.5% of total salaries

MOH MAINTENANCE BUDGET-1976 BY REGION

HEALTH REGION	MAINTENANCE ALLOCATIONS - NON SALARY FUNDS										SALARY ALLOCATIONS		
Health Facility	Office Equip.	Medical Equip.	Buildings & Install.	Contract Maint.	Comm. Equip.	Trans. Equip.	Educ. & Rec.Equip.	Tools	Spare Parts Transp.	Spare Parts Machinery	Maint. Personnel Numbers	Maint. Salaries Annual	Total Salaries in facility Annual
REGION V													
Headquarters	100												
Hospital Occidente	250	250	0	0	480	300			200		9	10,200	344,532
Hospital Clínica Torax	25	350	160								0	0	17,448
Hospital Totonicapán	40		300			200			300		1	1,920	90,612
Hospital Sololá	150	600							100		1	1,920	74,448
Hospital Quiché		180				200			200		1	1,920	101,280
Hospital Huehuetenango	100	200	200			200			200		3	4,800	110,028
TB Hospital Huehuetenango	50		60			10					0	0	33,500
Hospital San Marcos								50	95		1	1,920	85,332
Hospital Pedro Necta										500	1	1,680	32,076
Hospital Rodolfo Robles	(No Data)										1	1,200	94,440
Total 9 Hospitals	715	1580	720	0	480	910	0	50	1095	500	18	25,560	983,696
22 Health Centers	231	847	300	0	0	235	0	0	0	100	0	0	494,456
130 Health Posts	0	0	0	0	0	0	0	0	0	0	0	0	-------
7 Mobile Units	0	0	0	0	0	0	0	0	0	0	0	0	-------
	946	2427	1020	0	480	1145	0	50	1095	600	18		

Total Maintenance

Pers.	$ 25,560
Non Pers.	7,763
Total	$ 33,323

Total Budget Hospital Salaries = 983,696
Total Budgeted Maintenance force= 25,560
Maintenance Personnel = 2.5% of total salaries

MOH MAINTENANCE BUDGET-1976 BY REGION

HEALTH REGION	MAINTENANCE ALLOCATIONS - NON SALARY FUNDS										SALARY ALLOCATIONS		
Health Facility	Office Equip.	Medical Equip.	Buildings & Install.	Contract Maint.	Comm. Equip.	Trans. Equip.	Educ. & Rec. Equip.	Tools	Spare Parts Transp.	Spare Parts Machinery	Maint. Personnel Numbers	Maint. Salaries Annual	Total Salaries in facility Annual
REGION VI													
Headquarters	1000	0	0	0	0	0	0	0	75	0			
Hospital Cobin	60	100	0	0	26	250	0	75	200	0	3	3840	127,416
Hospital Salamá	0	0	150	0	0	10	0	0	280	0	1	1920	64,404
Total 2 Hospitals	1060	100	150	0	26	260	0	75	555	0	4	5760	191,820
Total 8 Health Centers	300	418	460	0	0	0	30	60	100	0	0	0	220,520
Total 22 Health Posts	0	0	0	0	0	0	0	0	0	0	0	0	
Total 1 Mobile Unit	0	0	0	0	0	0	0	0	0	0	0	0	
	1360	518	610	0	26	260	30	135	655	0			

TOTAL MAINTENANCE

Pers.	$ 5,760
Non Pers.	3,594
Total	$ 9,354

Total Budgeted Hospital Salaries - 191,820
Total Budgeted Maintenance Salaries - $5,760
Maintenance = 3% of total salaries

MOH MAINTENANCE BUDGET-1976 BY REGION

HEALTH REGION	MAINTENANCE ALLOCATIONS - NON SALARY FUNDS										SALARY ALLOCATIONS.....		
Health Facility	Office Equip.	Medical Equip.	Buildings & Install.	Contract Maint.	Comm. Equip.	Trans. Equip.	Educ. & Rec.Equip.	Tools	Spare Parts Transp.	Spare Parts Machinery	Maint. Personnel Numbers	Maint. Salaries Annual	Total Salaries in facility Annual
REGION VII													
Headquarters	0												
Hospital San Benito	40	110								300	2	3840	70,380
Hospital Melchor de Méncos	50	70							60		1	1080	48,276
Total 2 Hospitals	90	180							60	300	3	4920	118,656
Total 4 Center	205	235	0	100	0	50	0	0	10	0	0	0	107,100
Total 10 Posts	0	0	0	0	0	0	0	0	0	0	0	0	---
	295	415	0	100	0	50	0	0	70	300			

MAINTENANCE TOTAL

Pers.	$ 4,920
Non Pers.	1,230
Total	$ 6,150

Total Hospital Budgeted Salaries $ 118,656
Total Maintenance Budgeted Salaries 4,920
Maintenance = 4% of budgeted Salaries

MOH TRANSPORTATION MAINTENANCE BUDGET-1976

(less aqueducts and Sanitary Engineering)

MOH HEADQUARTERS TRANSPORTATION MAINTENANCE ALLOCATIONS

Materials and Equipment		$ 87,240
Tools	$ 1,500	
Spare Parts	36,000	
Paint	1,000	
Leather	200	
Plastic and nylon	200	
Glass	100	
Metal and non-metal	430	
Electrical equipment	300	
Miscellaneous and rags	410	
Iron work	100	
Tires	47,000	
Repair Personnel (in Malaria Division Budget)		27,240
Maintenance of Departmental Cars		41,330
Epidemiology	3,000	
Field Operations	31,180	
Strengthening Rural Health	5,000	
Other departments	2,150	
TOTAL (Headquarters Transportation Maintenance Budget)		$155,810

REGIONAL TRANSPORTATION MAINTENANCE ALLOCATIONS

(See Appendices 1 (a) - 1 (i))

Metropolitan Region	8,860	
Region I	1,734	
Region II	1,713	
Region III	530	
Region IV	1,485	
Region V	2,240	
Region VI	915	
Region VII	120	
TOTAL (Region Transportation Maintenance Budget)		$ 17,597
GRAND TOTAL (MOH Transportation Maintenance Budget)		173,407*

* Gasoline and oil are not included: $300,000 plus that co-mingled with cost of fuel at local activities. Gasoline increased to $ 360,00 in 1977.

Source: 1976 Budget, Department of Statistics.

SUMMARY OF MOH TRANSPORTATION COSTS BASED ON 1977 BUDGET*

Personal services		$149,200
Non-personal services (travel mechanics)		11,200
Materials and supplies		450,850
Tires and tubes	$ 50,000	
Gasoline and oil	350,000	
Spare parts	40,000	
Miscellaneous	10,850	450,850
Total		$611,250

There are 342 four-wheel vehicles.
There are 231 motorcycles.

The maintenance staff consists of:

1	blacksmith
13	mechanics
2	aids who work as mechanics
1	painter/body worker
14	mechanic helpers
31	Total

The central transportation repair shop is located in Guatemala City. If a vehicle breaks down outside of the city a mechanic is dispatched to perform repairs. If he is unable to repair the vehicle, it is towed to Guatemala City for repairs.

Average monthly work performed

50	lube and oil changes
115	minor repairs such as tune-ups, points, brakes, clutch adjustment, plugs.
3	major repairs
168	cars through the shop per month.

Gasoline is pumped at a central station. Gasoline costs are $350,000 plus personnel (included above) at $11,340. Chits for gas to outlying activities are sent from this central station and are accounted for from the central gasoline fund.

There is no record of the number of cars not in service.

* Source: Given to Carlos Duran by the Central Transportation Section.

APPENDIX 2(c)

MOH VEHICLE DISTRIBUTION

LOCATION / VEHICLE TYPE AND NUMBER	Automóvil	Jeep	Pickup	Camioneta Sport	Panel	Microbus	Autobus	Camión	U.Mov.Rayox X	Motocicletas	Ambulancias	TOTAL
GUATEMALA												
Hospital General San Juan de Dios		2	2					1			4	9
Centro de Salud # 1		5										5
Hospital Ramiro Gálvez		1		1								2
Disp. Antituberculoso Central				1								1
Higiene Escolar		1										1
Abastecimientos					1							1
Escuela de Enfermeras	1	1		1		1	1					5
Hospital Neurosiquiátrico		1	1				1	1			1	5
Hospital San Vicente								1			2	3
Hospital Roosevelt		5	1		1				1		11	19
Dispensario Infantil		1										1
Poliomielitis		1				1						2
Recursos Humanos						1						1
Planificación		2										2
Cementerio General		1						2				3
Zoonosis		2	1									3
Programación		1		1								2
Región Comunitaria				1								1
Pagaduría		1										1
Educación para la Salud		1										1
Región Metropolitana				1								1
Epidemiología				2	3							5
Materno Infantil		4	1	3					1			9
Control de Alimentos	1	2		1								4
División de Tuberculosis		6							2			8
Hospital Tipo Granja			1								2	3
Unepar		4	14	1				3				22
Saneamiento Ambiental				2				6				8
Programa Mundial de Alimentos		1	2					7				10
Transportes - Servicios Varios Grúa 1		7	3	2			1	4			1	19
Supervisión			7									7
AMATITLAN (AREA)												
Hospital Nac. de Amatitlán			1								1	2
Centro de Salud		1										1
SACATEPEQUEZ AREA				6							2	8
CHIMALTENANGO		5									3	8
CHIQUIMULA		1	1								3	5
PROGRESO		1									3	4
JALAPA		1	1								3	5
ZACAPA		2		2							5	9
JUTIAPA		3		1							2	6
SANTA ROSA		4	1	1							4	10
SUCHITEPEQUEZ		3		2							1	6
ESCUINTLA		5		1							3	9
RETALHULEU		3			1						4	8
QUETZALTENANGO		6		3	2			2			4	17
QUICHE		3	1	2							2	8
SOLOLA		2									2	4
TOTONICAPAN		2									2	4
SAN MARCOS		4		1							5	10
HUEHUETENANGO		4	1	1							2	8
SALAMA, B.V.		3		1							2	6
COBAN, A.V.		3		1							4	8
IZABAL		2	3	3		3	1					12
PETEN		2	1								4	7
PLANTA CENTRAL MOH HQ.	4	3	1	5								13
TOTAL MOH VEHICLES	6	113	44	47	8	6	4	27	4	231	82	343

TECHNICAL TRAINING PROGRAM

MAINTENANCE & ENGINEERING CENTER

FACILITIES FOR HOSPITALS OR HEALTH CENTERS

VENEZUELA

NOTE: The indicated period is approximate. The training program indicates the minumum prerequisite of previous experience. The program allows for personnel increase depending on its capacity. Training of supervisors and Physicians is stated in a separate program.

A
SANITARY
MAINTENANCE

OUTSIDE INSTALLATIONS

Yards and Trails
Outside Installation Equipment
Carpentry and Masonry - General
Paint - General
Plants and Vines

WASTE PICK UP

Containers
Hauling Equipment
Disposal Procedure
Inspection
Fire Prevention Equipment

WATER SUPPLY

Water Safety Standards
Water Supply Protection
Drinking Water Equipment
Water Service and Demand
Water Treatment and Tests

HOSPITAL SANITARY ENGINEERING

Bathroom Care
Water Passage Valves & Tanks
Traps
Ventilation & Ventilation Ducts
Water Circulation Pumps
Sewage Pumps
Drainage Pumps
Tanks Drainage Pipes

HOSPITAL MAINTENANCE

Mech. & Elect. Cleaning Equipt.

HOSPITAL MAINTENANCE (Cont.)

Chemical Cleaning Agents, Wax, Floors, Electricity Conductors
Disinfectants
Inventory Control Storage
Budgets and Estimate
Operators (Short Course)

SAFETY ALARMS & LIGHTING

Conductor Lines, Insulation & Ground
Fuses and Switch Boxes
Lighting Circuits and Maint.
Distribution of Wires, Conduits and Gauges
Wire, Fire and Theft Circuits
Lighting Devices Maintenance

PRACTICAL BASIC ELECTRICITY

Basic Electrical Systems
C.P.C.A. Studies, Transformers, Condensers, Motors, Fuses, Circuits, Switches, Rectifiers, Measuring Instruments, Basic Engine Control, Electrical Safety

CONCEPTS OF HOSPITALS & ORGANIZATION

Organizational Structure
Departments
Medical Terms - General
Maintenance Areas - General
Hospital Safety - Accident Prevention
Fire Protection and Prevention in the Hospitals

The prerequisite for Course A is 3 months of previous experience.

B
LAUNDRY

DELIVERY AND RECEIVING

Delivery Registration
Markings
Handling of Bundles for Shipment
Safety of Materials

CLEANING ELEMENTS

Types and Uses
Inventory Control & Storage
Fire-Proof Container & Storage
Inventory - Replacement Calendar
Fire Protection and Prevention

LAUNDRY MACHINES

Machine Distribution - Loads
Types of Equipment, Irons, Boards, Starch Covering, Extractors, Flat Irons, Package Tying, Garment Marking, Sewing Machines, Shirt Pressing Machines, Soap Containers, Agitators, Dryers, Washers, Inventory Control, Preventive Maintenance, Repairs, Estimates and Costs, Operators (Short Course)

ELECTRICAL CONTROL WIRING

Line Pullers
2- and 3-Wire Controls
Engine Reversion, Brakes and Shocks
Rectification Circuits (CA - CD)
Relay Controls, Lights, Indicators
"Sound State" Controls
Fluid Level and "Purge" Control

PRACTICAL STANDARDS FOR MAINTENANCE SHOPS

Tools Mechanical Manual
Power Tools
Welding, Sketching, Reading of Drawings
Pipes, Valves, Distribution Lines, Tools
Program of a Maintenance Plan
Programming of Maint. Inspection
Inventory Upkeep

WIRING AND USE OF TOOLS

Use of Electrical Hand Tools
Use of Electrical Materials
Electrical Connections/Insulation
Electric Lighting Circuits
Electric Heating Circuits
Power Machines - Tool Maintenance
Electrical Codes - Hospitals

CONCEPTS OF ELECTRICITY

Electricity and Life
Electricity, Batteries/Chargers
Reversibility - Elec. & Heat
" & Mechanical Movements
" & Light
Concepts of the System

The prerequisite for Course B is 4 months of previous experience.

C
FOOD SERVICE

WASTE PICK UP AND CHEMICAL TREATMENT

Disposal Methods
Containers
Inspection
Hauling Equipment
Chemical Treatment

CLEANING ELEMENTS

Types and Uses
Inventory Control & Storage
Consumable Materials - Sponges, Dish Cloths, etc.
Fire Protection and Prevention

FOOD SERVICE EQUIPMENT

Vegetable Cookers
Ovens, Ranges, Cold Storage Rooms (Vegetables, Meat)
Carts, Personnel Sanitary Care
Inspection, Dish Washing, Garbage Crushers
Cost and Estimates
Operators (Short Course)

ENGINE MAINTENANCE

Engine Construction
Preventive Maintenance
Lubricants
Boxes and Straps
Gas and Humidity Control Devices
Sparks and Explosion Safety
Electricity Dangers

The prerequisite for Cource C is 4 months of previous experience.

D
COOLING AND AIR CONDITIONING

COMPRESSED AIR

Oxygen Systems, Flux Valves,
Measuring Devices, Tanks,
Regulators, Safety Traps,
Vacuum Pumps, Compressors,
Storage Tanks, Alarm Systems,
Pipes O_2 and N_2O
Liquid Oxygen Stations

HOSPITAL SYSTEMS

Compressors 1 -20 7 cm.
Piping and Insulating Lines
Large Boxes - Cold Storage
Quick-Freezing, Air Conditioning
Duct Unit Capacity - 8 TU
Unit Capacity

BASIC REFRIGERATION

Concepts of Refrigeration
Kinds of Systems
Cool Air, Water, Forced Air,
Sealed, Semi-Sealed
Gasses, Charges, Measurement
and Test Instruments
Tools, Catalogs, Inventory,
Control
Types of Valves

MECHANICAL VENTILATION

Types of Ventilators, Kitchen
Equipment, Dining Hall Areas,
Auditoriums, Bathrooms, Sewers
Dehumidifier Equipment
Suction Equipment
Air Filters and Piping
Operators (Short Course)

The prerequisite for Course D is 6 months of previous experience.

C & D
MAINTENANCE SHOP

Filing Distribution - Data, etc.
Shop Equipment
Inventory Control
Storage of Supplies
Maintenance Steps
Catalogs
Supply Sources
Laboratory Instruments
Safety Standards

The prerequisite for Course C is 4 months of previous experience.

The prerequisite for Course D is 6 months of previous experience.

E
BOILERS

HOT WATER SUPPLY

Water Heating Methods
Water
Hot Water Demand
Hot Water Equipment
Temperature Control

Sub-stations Maintenance
Shock in Power Line,
"Solid State"
Circuits
Repair Procedures
Sketching - Reading of Drwgs.

CHIMNEY CONTROL

Chimney Control & Adjustments
Combustion Care

CONTROL VALVES

Uninterrupted Solenoid Level
Depressurized Diaphragm
Floating Shock Absorbers,
Grafts, Pressurizers,
Measurers

General Maintenance

BURNERS

General Design
Oil - Gas - Charcoal
Steam and Water Systems
Fire Danger, Burner, Vaporizer
Oil Storage, Pilots

POWER TRANSFORMERS (DISTRIB)

Type and Capacity of Transformers
Three-phase connections
Delta/Y
Tests, Charges, "Ground"
Power Distribution - Prim/Sec.

The prerequisite for Course E is 6 months of previous experience.

F
EMERGENCY PLANTS

FUELS AND LUBRICANTS

Types of Fuels - Applications
Oil Structures - Applications
Handling and Storage
Inventory Control
Fire Prevention

Protection

EMERGENCY LIGHTING EQUIPMENT

Dry Batteries, Chargers, Types
of Lamps
Equipment Capacity
Spare Parts - Preventive Maint.

POWER PLANTS

Diesel Engines
Procedures and Tools
Lubricants - Preventive Maint.

Operators (Short Course)

GENERATORS AND CONTROLS

Charging Test
Incasement
Maintenance Procedures
Power Devices "Solid State" C.D.
Batteries, Chargers, Ventillation

The prerequisite for Course F is 6 months of previous experience.

G
ELEVATORS

TELEPHONE SYSTEMS

Circuits - Wiring
Services

ELEVATOR EQUIPMENT & CONTROL

Preventive Maintenance

TRANSISTORS - PRINCIPLE

Diode and Transistors Characteristics
Ways, Amplifiers Tests and Measurements

CIRCUITS - ELECTRONICS

Regulators
Amplifiers
Phase Converters - Push/Pull
Filters - Bands
Transductors
Repairs

INTENSIVE CARE OPERATING ROOM

Gasses
Static Charges - Floors
Equipment Ground Connections
Explosion-Proof Equipment
Sterilized Bedding / Dresses (Gowns)

The prerequisite for Course G is 7 months of previous experience.

H
X-RAYS

Photographic Equipment

IMAGE INTENSIFIERS

T.V. CLOSED CIRCUIT

X-RAYS SYSTEMS, CONTROLS

X-Ray Screens
Fluoroscopes

X-RAY PRINCIPLES AND EQUIPMENT

Radiation - Safety
Barrier Thickness
Tubes and Sources of Power Equipment

SOLID STATE PRACTICES MANUAL

Circuit Study
Temperature Control
Sensitive Devices
Preparation of Reports

CIRCUIT PRACTICES MANUAL

Construction of Circuits, Measuring
Amplifiers' Tests

BASIC ELECTRONICS PRACTICES MANUAL

Alternating Current Tubes
Amplifiers, Rectifiers
Feeding Sources

The prerequisite for Course H is 10 months of previous experience.

I
MEDICAL EQUIPMENT

MEDICAL EQUIPMENT

Arm and Leg Baths
Plaster Cutters, Incubators
Microscopes, Cauterizers
Respirators

LABORATORY EQUIPMENT

Spectrometer
Oxymeter, pH.
Operating Room Lighting

LABORATORY EQUIPMENT

Distillers
Anesthesia, Gas, Centrifuges
Resucitators, Operation, Suction
Autoclaves

COMMUNICATIONS SYSTEM

Calling
Amplifiers
Telephones

The prerequisite for Course I is 10 months of previous experience.

J
ELECTRONIC SYSTEMS

INTENSIVE CARE OPERATING ROOM

Pacemakers Defibrilators
Master Control Monitors
Nerve Stimulators
Temperature Registers
Oxygen Pumps
Surgeons' Assistant

PATIENT'S MONITOR EQUIPMENT

E.E.G.
G.K.G.
E.M.G.
Muscular Stimulators, Monitors, Audiometers

INTEGRATED CIRCUITS

Modern Solid State Devices
for Medical Instruments

The prerequisite for Course J is 12 months of previous experience.

APPENDIX 4

TOOL REQUIREMENTS

Tools are required at the national, regional and local levels to maintain health facilities, equipment and vehicles. Estimated tool requirements are presented for (1) the National Clinical Engineering Repair Shop (2) the Regional Maintenance Repair Shop, and (3) local health facilities. These estimates are based upon recent experience in Nicaragua in the development of similar levels of maintenance services.

The exact needs for tools in Guatemala can be made only after the completion of a national inventory which specifies in detail the facilities, equipment and vehicles which exist.

The equipment lists which follow are presented only as guidelines for the formulation of a final tool list once the determination has been made about the kind of maintenance which will be done and the specifications of the equipment to be maintained.

1. TOOL REQUIREMENTS FOR NATIONAL CLINICAL ENGINEERING REPAIR SHOP

These tools should not be purchased unless a training program is initiated as part of a national maintenance program.

1 Oscilloscope dual trace DC to 15 MHz, Model 10-4510 with x 10 probes, Heathkit.

1 Oscilloscope tektronic 564 dual trace, memory type with algebraic addition. Feature and x 10 proves. Heathkit.

1 Hewlett Packard digital multimeter. AC powered Model 3476A Automatic DMM

1 Same as Above but for AC/DC with rechargeable batteries Model 3476B. Automatic DMM.

1 Option for both above No. 11067A. Test Lead Kit.

2 No. 11068 A soft carrying case, for above.

1 No. 11096 A RF Kit with adaptor. (10 MHz to 700 MHz) for testing AC voltage. Hewlett Packard.

1 Voltmeter AP-9-0/150/300 VAC General Electric No. GE-50-20102 RHRH (Accuracy 3/4% Full Scale).

1 Voltmeter AP-9 - 0/10/20 VAC. General Electric No. GE-50-20102 NANA.

1 Weston Model 931. D.C. Voltmeter.

1 Cycle Counter Model S1. Made by: Standard Electric Time Co.

1 Milliammeter AP-9.0/75/150 MA A.C. General Electric No. GE 639-13

1 Milliammeter two scale 0-550 MA-055 MA type quick acting meter. A/1/84013. Simson Electric SK 525-447.

1 Recording AC Ammeter/Volt Meter: Range 0-5/25/100/250 Ampere. Range 95 to 130 and 150 or 300 Volt AC. 12"/hour chart speed. Weston Instrument.

1 Variable Voltage source (variac). 0-150 V. 8 Amp. capacity No. E-2101-11 taken from page 334 Scientific Products Catalog No. 76.

1 Leakage tester millivolts/microampere meter similar to "Camsafe" from Cambridge Instrument Co.

1 Isolation transformer leakage tester. 0 to 500 Micro Amp.

1 Direct Reading Capacitor Checker range from 10 PE to 1000 MF. Kit it-28 Heathkit.

1 Digital Multimeter Model 8035 DVOM Cat. No. G-200 Tripplett.

1 Voltage Source Millivolts. (potentiometer) range: from Zero Millivolt to 1 volts lead and northrup.

1 ECG. Electronic patient No. 007167 (Mechanical Heart) Made by The Burdick Corporation, Milton, Wisconsin 53563 U.S.A.

1 Stereo scope microscope. Model SVB-73 No. 31-26-4-73.

1 Logic trouble shooting kit. Hewlett Packard Model 5011T with all options.

1 Function Generator. KIT IG-1271. Range from 0.1 Hz to MHz. Heathkit Catalog January 75, page 57.

1 Capacitor Resistence Bridge (RCL) (Impedance Bridge) KIT 1B-2 Heathkit Catalog January 1975, page 57.

1 IN-Circuit Pet/Transistor Tester, Kit IT-121. Heathkit Catalog January 1975, page 56.

1 Tube and transistor tester No. 7394K2 page 1005 McMaster Carr. Catalog No. 80.

1 Sharpener f. surgical instruments and surgical equipment: Precision hone Carr McMaster, 8" 4349 D12 # 50.

1 6 inch wheel grinder No. 4377A 14, Carr McMaster.

1 5" Jaws medium duty vises stock No. 2Z473 page 170 Cat. Motor Book No. 341 W.W. Grainger Inc.
Tachometer, Photo Model 36, No. C 3315-1. Cat. No. 76 Scientific Products Div. of American Hospital Supply Corporation. 1430 Waukegan Road McGraw Park, Illinois 60085.

1 46B 186 Dual-in-line. Ic Extractor.

1 46B 188 To 5. Ic Extractor, page 104 Jensen Tool.

1 Piggy Back Nutdriver Kit No. 3B120 page 16 Jensen Tool.

1 Screw Extractor No. 36B511, No. 88 B 015 page 43 Jensen Tools.

1 4 Way Offset Screwdriver, No. 39B351, page 42 Jensen Tool.

1 Offset drivers, set of 5, Jensen 36B287, Page 43.

1 Heavy Duty Bolt Cutter No. 185 B 051 page 43 Jensen Tool, for Electronic shop.

1 Quick-pick tools, No. 60 B 330 page 44 Jensen Tool.

1 Flexible pick-up tool, No. 60 B 265, page 48, Jensen Tool.

1 Litetuff Rugged Tenite Parts Box, No. 93 B 115 (26A), Jensen Tool.

1 Complete Clam-on Ammeter. Set No. 56 B 240. Page 74 Jensen Tool.

1 Dip-clip No. 136 B 792 page 75, Jensen Tool.

1 Spring Hose Clamp Pliers No. 5770 A 1; No. 5770 A 5 page 1318 Catalog 80 McMaster Carr Supply Co.

1 Tube Tongs No. 8532 A 14 Straight Unit page 1320 Cat. 80 McMaster Carr.

6 A.C. Receptacle wiring tester, No. 70118 K 11 page 999 McMaster Carr.

1 Terminal Crimping Tools, Heavy duty No. 7114 N 14 Page 991 McMaster Carr, Catalog No. 80.

1 Soldavac Model SV-026, No. 65 B 029 page 104 Jensen Tool.

1 198 B 502 torch, page 106, Jensen Tool.

3 J TK-77 Tool Kit with meter page 52 catalog Jensen spring Catalog 1976.

3 Multiple Outlet Junction Box # 60 B 111. Page 4, Jensen Tool.

3 Heavy Duty Wire Cutters, No. 14 B 81 page 4, Jensen Tool.

3 Tap Wrench and Guide No. 201 B 107 page 5 Jensen Tool.

3 Mechanical Screw Starter with magnetic retriever Regular Slot No. 69 B 115 page 11, Jensen Tool.

3 39H148 Swivel Vacu Vise - Jensen Tool.

3 RJ-1856 Slide-on Rubber Jaw - Jensen Tool.

3 RP-1858 Replacement Rubber base pad. Jensen Tools.

3 Illuminated Magnifier, No. 28 B 200 (Model LFM - 1 A) Jensen Tool page 128.

3 Feeler Gauges No. 14 B 409 page 114, Jensen Tool.

1 Small Bench Grinder No. 2 z 425 page 214 from Cat. No.341 W.W. Grainger Inc.

1 No. 3 Z 428-2 H.P. Compressor. page 347 Cat. 341. W.W. Grainger Inc.

1 Drill Guide No. 185 B 011. page 88 Jensen Tool.

1 Ultrasonic Leak Detector. Made by Hewlett Packard.

1 Balance Weight set (Class C) No. 4-693-05. Cat. Greiner Scientific Corporation, 22 North Moore Street, New York, N.Y. 10013

1 60 piece high speed drill set. No. 146 B 140.

1 Tiny precision drills No. 31 B 255 page 83 Jensen Tool.

1 Drill Sharpener No. 39 B 325.

1 22 B 210 Complete Kit Model 261 (small drill and grinder) page 84 Jensen Tool.

1 Metal Nibbler No. 74 B 130 AN-1-tool.

1 No. 74 B 133 Replacement Punch, page 90 Jensen Tool.

1 Tap and die sets, No.146 B 180 Inch Set. page 91 Jensen Tool.

1 JYK-3 Miniature Precision Kit, Jensen Tools page 58.

1 Depth Micrometer, 0 to 3" Tumico Model D-2 ½-3 or equal. Tubular Micrometer Co.

1 U Tube Water Manometer, Fisher Model 11-286 or equal scales: 0 to 36" H20 and 0 to 90 cm H20. Fisher Scientific Co.

1 Test Flowmeter: 1) 7.5 to 94 LPM oxygen at 14.7 p.s.i. 70° F. Guaranteed 2% accuracy, 3/4" NPT inlet. Direct reading scale. Maximum pressure drop at maximum flow not more than 1" H20 Tube: FP-3/4-27-G-10 Float: 3/4 Gusvt--10, Fischer & Porter Model 10 A 1735 CX-3 or equal. Fishcer & Porter Co.

1 9 to 11.2 LPM Oxygen at 14.7 p.s.i. 70° F. Guaranteed 2% accuracy, ¼" NPT inlet, Direct reading scale, Maximum pressure drop at maximum flow not more than 2" H20. Tube: FP ¼ 25-25. Float: ¼ CD-glass.

Fischer & Porter Model 10 A 1735 CX-4 or equal.

1 .05 to 4 LPM Oxygen at 14.7 p.s.i. 70° F. Guaranteed 2% accuracy, ¼" NPT inlet. Direct reading scale. Maximum pressure drop at maximum flow not more than 33" H20. Tube FP 1/16 -20-G-5 Float: 1/16-55. Fishcer & Porter Model 10 A 1735 X-5 or equal.

1 Pressure regulator, Norgren Model 11-004-016 or equal. C.A. Norgren Co,

1 Pan Rap Tool GS2B. Panduit Corp.

ADDRESSES

JENSEN TOOLS AND ALLOYS
4117 North 44th
Phoenix, Arizona 85018

TRIPLETT CORPORATION
Blufton, Ohio 45817

HEWLETT PACKARD
1501 Page Mill Road
Palo Alto, California 94304

W.W. GRAINGER INC.
945 "V" Street, N.E.
Washington, D.C. 20018

HEATH-SCHLUMBERGER CO.
International Division
P.O. Box 440
St. Joseph, Michigan 49085

ARTHUR H. THOMAS COMPANY
Vine Street at Third
P.O. Box 770
Philadelphia, Pennsylvania 19105

McMASTER CARR
P.O. Box 4355
Chicago, Illinois 60680

Cost of Tools for National Clinical Engineering Repair Shops.

The costs are included with the Central Region Repair Shop costs because they will be located in the same facility and will share personnel, tools and equipment. (See Part III of this report for Central Region Repair Shop description.)

2. TOOL REQUIREMENTS FOR REGIONAL MAINTENANCE WORKSHOP

The tools required for these repair shops should be determined only after a detailed inventory is made of the types and specifications of equipment used within the region.

The U.S. Army Standards for Equipping Hospital Workshops (Appendix 5) is included as a guide to be used for equipment purchase once a specific analysis of needs is made.

Costs of Tools. Based on the recent experience of Nicaragua in purchasing tools for Regional Repair Shops, the estimated costs are:

$10,000	Eastern Region Repair Shop
10,000	Western Region Repair Shop
20,000	Central Region Repair Shop (includes National Repair Shop)
$40,000	

(Under no circumstances should the Central Regional Repair Shop be considered separately from the National Clinical Engineering Repair Shop. They will share personnel, equipment and facilities and will be the responsibility of one director.)

3. TOOL REQUIREMENTS FOR LOCAL HEALTH FACILITIES

The exact type of tools needed will depend upon the complexity of the equipment at the facility, but in general tool needs are very simple because the equipment is very simple.

A. Health Posts, will need a standard tool kit consisting of:

pliers
screw drivers
hammer
miscellaneous small tools

Cost of tools

Cost per unit	$ 20.00
Per 300 Health Posts	$6,000.00

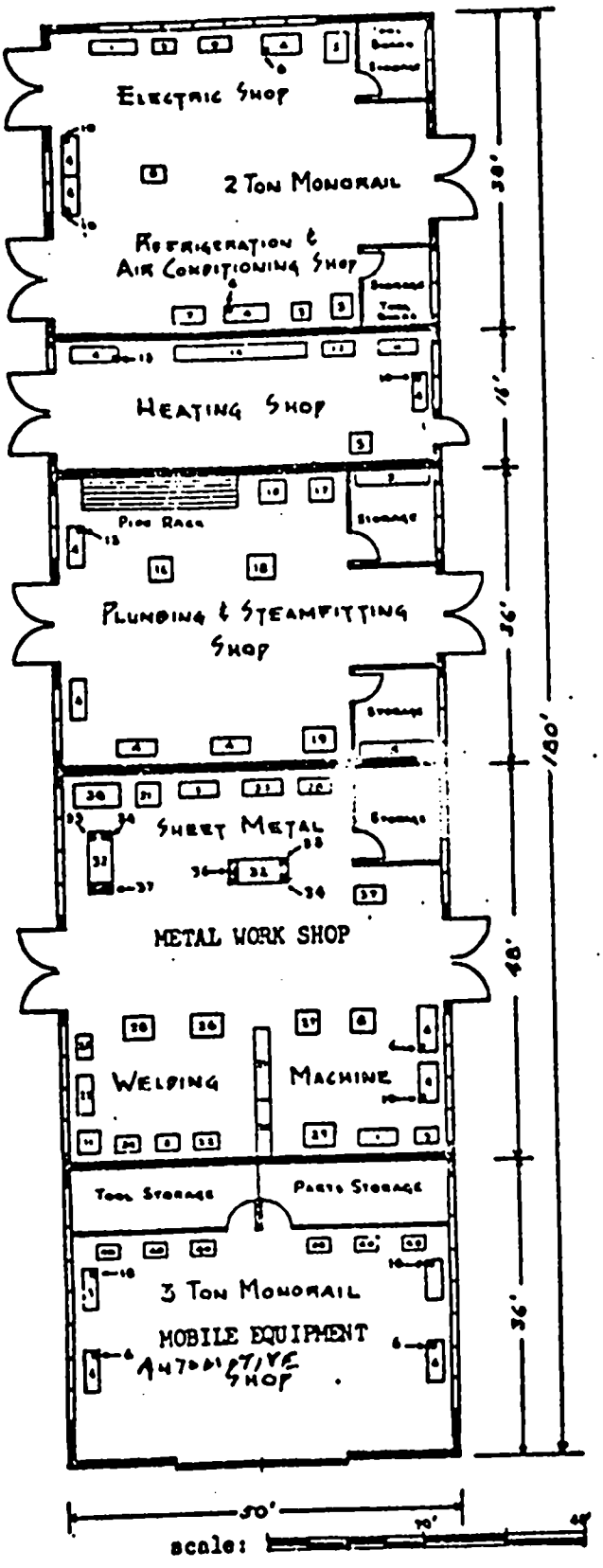
B. Health Centers, will need the standard tool kit recommended for Health Posts plus more sophisticated tools depending on the size of the health center and the equipment available, i.e.,

pliers
screwdrivers
hammers
wrenches
circuit testers
miscellaneous small tools

Cost of tools

Cost per unit	$ 200.00
Per 82 Health Centers	$16,400.00

RECIBIDO
8 JUL 1975
Oficina Sanitaria Panamericana



1 Lathe, metal
2 Bender, conduit
3 Scale, platform, floor type
4 Bench, work
5 Cabinet, tool
6 Vise, bench
7 Truck, 2-wheel, appliance type
8 Drilling, Machine, Upright, floor Mtd
9 Pot, Soldering
10 Grinder, bench
11 Forge, blacksmith
12 Furnace, soldering
13 Vise, pipe, hinged
14 Rack, storage
15 Threading machine, pipe thread
16 Bender, vise and stand
17 Furnace, soldering, portable
18 Tapping machine, pipe.
19 Welding and cutting set, oxyacetylene.
20 Bin, storage
21 Rack, bar stock
22 Welder, electric, portable
23 Table, welding, adjustable
24 Anvil, blacksmith
25 Welding kit, portable
26 Saw, hack, electric
27 Press, arbor
28 Milling Machine
29 Shaper, metal
30 Rack, storage, sheet metal
31 Saw, metal, electric, contour and filing.
32 Bench, work, wood
33 Edging machine, bench type
34 Edger, elbow, sheet metal
35 Shear, squaring
36 Bending brake, and bar folder
37 Sander, belt, heavy duty
38 Bending brake, 8 ft. 18 gauge
39 Former, slip roll, bench type
40 Tool totters

Figure 8. Arrangement of equipment.

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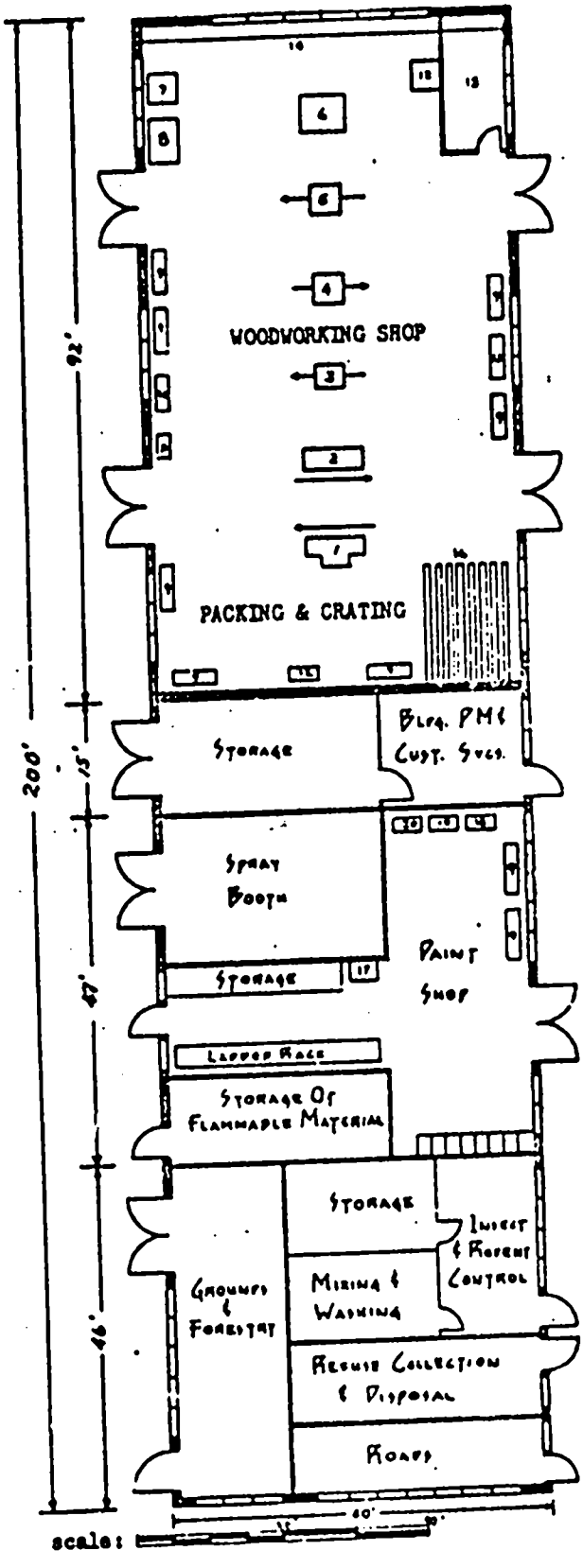
U.S. ARMY STANDARDS FOR EQUIPPING HOSPITAL WORKSHOPS



1 Saw, cut off
2 Jointer, 8 in. or 12 in.
3 Planer, 18 in. or 24 in.
4 Saw, table
5 Saw, band
6 Shaper, 3 hp or 5 hp
7 Sander, Finisher
8 Lathe, wood
9 Bench, work
10 Mortiser
11 Drilling machine, floor mtd.
12 Sander, drum
13 Saw, filer
14 Low bench for tool chests.
15 Tool panel and storage
16 Shop stock of lumber
17 Mixer, agitator
18 Embossing machine
19 Stencil cutting machine
20 Sander, portable

Figure 2—Continued.

TACHI 1846-A

Appendix I. GUIDE FOR HEAVY SHOP EQUIPMENT

Number of civilian and military employees permanently assigned to the maintenance and operations organization, including preventive maintenance, custodial services, insect and rodent control, packing and crating.

Strength—(R & U)	----------	76 90	91 135	136 175	176 215	216 260	261 320	321 360	361 390	391 471	476 600
Building floor area (million square feet)											
Floor area (Installation)	----------	0.125– 0.25	0.25– 0.75	0.75– 1.25	1.25– 1.75	1.75– 2.5	2.5– 3.6	3.6– 4.7	4.7– 5.8	5.9– 9.0	9.0– 14.0
Installation military strength											
Strength—(Military)	----------	501– 1,000	1,001– 3,000	3,001– 5,000	5,001– 7,000	7,001– 10,000	10,001– 15,000	15,001– 20,000	20,001– 25,000	25,001– 40,000	40,001– 60,000
Estimated Requirements											
Item	Approx unit cost	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
ELECTRIC SHOP											
Bench, work	$100.00	1	1	1	1	1	1	2	2	2	2
Bender, conduit, hydraulic	300.00	----------	1	1	1	1	1	1	1	1	1
Cabinet, tool	30.00	1	1	1	1	1	1	2	2	2	2
Drilling machine, upright, floor mtd	106.00	1	1	1	1	1	1	1	1	1	1
Drill, portable, electric, ¼ in	20.00	1	1	1	1	1	1	2	2	2	2
Drill, portable, electric, ½ in	50.00	1	1	1	1	1	2	2	2	2	2
Grinder, bench, 2 wheels	50.00	1	1	1	1	1	1	1	1	1	1
Hammer, electric, portable	150.00	----------	----------	----------	----------	----------	1	1	1	1	1
Hoist, chain, 1-ton	60.00	----------	1	1	1	1	1	1	1	1	1
Lathe, metal, floor type, 10 in	810.00	----------	----------	----------	----------	----------	1	1	1	1	1
Pot, soldering	10.00	1	1	1	1	1	1	1	1	1	1
Vise, bench	50.00	1	1	1	1	1	1	2	2	2	2
REFRIGERATION and AIR CONDITIONING SHOP											
Bench, work	$100.00	1	1	1	1	1	1	1	1	1	1
Cabinet, tool	30.00	1	1	1	1	1	1	1	1	1	1
Drill, portable, electric, ¼ in	20.00	1	1	1	1	1	1	2	2	2	2
Drill, portable, electric, ½ in	50.00	1	1	1	1	1	1	2	2	2	2

Grinder, bench, 2 wheels	60.00	1	1	1	1	1	1	1	1	1
Scale, platform, floor type	100.00	1	1	1	1	1	1	1	1	1
Truck, 2-wheel	30.00	1	1	1	1	1	1	1	1	1
Vise, bench	50.00	1	1	1	1	1	1	2	2	2
HEATING SHOP										
Bench, work, wood	850.00	1	1	1	1	1	1	2	2	2
Cabinet, tool	30.00	1	1	1	1	1	1	1	1	1
Forge, blacksmith	100.00						1	1	1	1
Furnace, soldering	15.00	1	1	1	1	1	1	1	1	1
Grinder, bench	50.00	1	1	1	1	1	1	1	1	1
Rack, storage	50.00	1	1	1	1	1	1	1	1	1
Vise, pipe, hinged	10.00	1	1	1	1	1	1	1	1	1
PLUMBING and STEAMFITTING SHOP										
Bench, work, wood	850.00	1	1	1	1	1	1	2	2	2
Bender, vise and stand	60.00	1	1	1	1	1	1	1	1	1
Cabinet, tool	30.00	1	1	1	1	1	1	1	1	1
Drill, portable, electric, ½ in.	20.00	1	1	1	1	1	2	2	2	2
Drill, portable, electric, ⅝ in.	30.00	1	1	1	1	1	2	2	2	2
Furnace, soldering	15.00	1	1	1	1	1	1	1	1	1
Rack, stock and bench	50.00	1	1	1	1	1	1	1	1	1
Rack, stock	50.00	1	1	1	1	1	1	1	1	1
Rodder, power, heavy duty; trailer mounted; with following accessories:	1300.00				1	1	1	1	1	1
(Normally used in activities of the sanitation section)										
Auger, sq. stock, 4 in., 6 in., 8 in. set					1	1	1	1	1	1
Cable, flexible, steel, feet					300	300	300	300	300	300
Cutter, root					1	1	1	1	1	1
Handle, ratchet					2	2	2	2	2	2
Handle, turning					2	2	2	2	2	2
Holder, rod guide					1	1	1	1	1	1
Rods, screw type, 3 ft. ea.					138	138	138	138	138	138
Tapping machine, pipe	50.00	1	1	1	1	1	1	1	1	1
Threading machine, pipe thread	200.00	1	1	1	1	1	1	1	1	1
Vise, pipe, hinged	10.00	1	1	1	1	1	1	1	1	1
Welding and cutting set, oxyacetylene	100.00	1	1	1	1	1	1	1	1	1
METAL WORK SHOP										
(1) *Sheet metal*										
Bar folder, hand-operated, bench-type, 30 in. long, 22-gauge cap.	885.00	1	1	1	1	1	1	1	1	1

Estimated Requirements—Continued

Item	Approx unit cost	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
Bench, work, wood	$50.00	1	1	1	1	1	1	1	1	1	1
Bending brake, floor mtd., 8 ft., 18 gauge cap	200.00	1	1	1	1	1	1	1	1	1	1
Burring machine, 22-gauge iron and lighter cap	25.00	1	1	1	1	1	1	1	1	1	1
Cabinet, tool	30.00	1	1	1	1	1	1	1	1	1	1
Crimping and beading machine	36.00	1	1	1	1	2	2	2	2	2	2
Drill, portable, electric, ¼ in	20.00	1	1	1	1	2	2	2	2	2	2
Drill, portable, electric, ½ in	50.00	1	1	1	1	1	1	1	1	1	1
Edger, elbow, sheet metal	35.00	1	1	1	1	1	1	1	1	1	1
Edging machine, bench type	28.00	1	1	1	1	1	1	1	1	1	1
Forming machine	55.00	1	1	1	1	1	1	1	1	1	1
Grooving machine	85.00	1	1	1	1	1	1	1	1	1	1
Rack, storage, sheet metal	50.00	1	1	1	1	1	1	1	1	1	1
Sander, belt, heavy duty	50.00						1	1	1	1	1
Saw, metal, electric, contour and filing	150.00						1	1	1	1	1
Shears, slitting, 8 in	100.00	1	1	1	1	1	1	1	1	1	1
Shears, squaring, 36 in	450.00	1	1	1	1	1	1	1	1	1	1
Shears, (uni-shear powered snips)	70.00	1	1	1	1	2	1	1	1	1	1
Welder, spot, pneumatic operated 18 in. throat, 15-gauge cap	800.00										
(2) *Welding*											
Anvil, blacksmith	$50.00	1	1	1	1	1	1	1	1	1	1
Cabinet, tool	30.00	1	1	1	1	1	1	1	1	1	1
Milling machine	600.00							1	1	1	1
Rack, bar stock	50.00	1	1	1	1	1	1	1	1	1	1
Saw, hack, electric	150.00	1	1	1	1	1	1	1	1	1	1
Table, welding, adjustable	150.00					1	1	1	1	1	1
Welding kit, portable	100.00	1	1	1	1	1	1	1	1	1	1
Welder, electric, portable	800.00	1	1	1	1	1	1	1	1	1	1
(3) *Machine*											
Anvil, blacksmith, 250 lb	$50.00	1	1	1	1	1	1	1	2	2	2
Bench, work, wood	50.00	1	1	1	1	2	2	3	3	4	4
Bin, storage	100.00	1	1	1	1	1	1	1	1	1	1
Drill, portable, electric, ¼ in	20.00	1	1	1	1	1	1	2	2	2	2
Drill, portable, electric, ½ in	50.00	1	1	1	1	1	1	2	2	2	2
Drilling machine, upright, floor mtd, 1 in. size, tilting table, drill center 18 in., slow speed, 110-220, 3-phase.	200.00	1	1	1	1	1	1	1	1	1	1
Forge, motor driven blower	87.00	1	1	1	1	1	1	1	1	1	1
Grinder, electric, bench, two 8 in. wheels, ½ hp motor.	50.00	1	1	1	1	1	1	1	1	1	1
Grinder, electric, floor mtd., two 10 in. wheels, 1 hp motor.	90.00	1	1	1	1	1	1	1	1	1	1

Grinder, electric, portable, T-bolt mounting, ¾ hp, in set of 43 items.	83.00					1	1	1	1	1	1
Lathe, metal working, floor model, 16-24 in. swing, 29½ in. between centers, back geared, screw cutting with wrenches, attachments and accessories.	2,200.00					1	1	1	1	1	1
Press, arbor	$100.00	1	1	1	1	1	1	1	1	1	1
Saw, hack, power driven, ½ hp motor	150.00					1	1	1	1	1	1
Shaper, metal	600.00							1	1	1	1
Vise, bench	50.00	1	1	1	1	1	1	1	1	1	1
Welder, electric arc, gasoline engine driven, 300 amp capacity, trailer mtd.	1,200.00					1	1	1	1	1	1
Welding outfit, with two stage regulators, set	100.00				1	1	1	1	1	1	1
MOBILE EQUIPMENT SHOP											
Bench, portable, with drawers	$70.00	1	2	3	4	4	5	5	6	6	6
Bench, work	100.00	1	1	1	1	2	2	3	3	4	4
Charger, battery	100.00	1	1	1	1	1	1	1	1	1	1
Drill, portable, electric, ¾ in.	20.00	1	1	1	1	1	2	2	2	2	2
Drill, portable, electric, ½ in.	50.00	1	1	1	1	1	2	2	2	2	2
Grinder, bench	50.00	1	1	1	1	1	2	2	2	2	2
Grinder, electric, valve refacer	150.00					1	1	1	1	1	1
Vise, bench	50.00	1	1	1	1	1	2	2	2	3	3
WOODWORKING SHOP											
Drill, portable, electric, ¾ in.	$20.00	1	1	1	2	2	2	2	2	2	2
Drill, portable, electric, ½ in.	50.00	1	1	1	2	2	4	6	8	8	8
Drill, portable, electric, ⅜ in.	60.00				1	1	2	2	4	4	4
Drilling machine, floor mtd, ½ in.	85.00	1	1	1	1	1	1	1	1	1	1
Grinder, bench, 2-wheel	50.00	1	1	1	1	1	1	1	1	1	1
Jointer, 8 in., 1 hp	250.00	1	1	1	1	1					
Jointer, 12 in., 5 hp	750.00						1	1	1	1	1
Lathe, wood-turning, 10 in. swing	150.00					1	1	1	1	1	1
Low bench for tool chests	50.00	1	1	1	1	1	1	1	1	1	1
Mortiser, hollow-chisel	487.00					1	1	1	1	1	1
Planer, 18 in., 3 hp	750.00	1	1	1	1	1					
Planer, 24 in., 7½ hp	1600.00						1	1	1	1	1
Sander, disc, 7 in.	30.00	1	1	1	1	2	2	2	3	3	3
Sander, drum 6 in. x 8 in.	135.00	1	1	1	1	1	1	2	2	2	2
Sander, portable, belt, 3 in.	55.00	1	1	2	2	2	2	4	4	4	4
Sander, semiportable, belt, 6 in.	115.00	1	1	1	1	1	1	1	1	1	1
Saw, band, 30 in., 3 hp	635.00	1	1	1	1	1	1	1	1	1	1
Saw, portable, electric, 9 in.	100.00	1	1	1	2	2	2	4	4	4	4
Saw, table, tilting arbor, 16 in.	600.00	1	1	1	1	1	1	1	1	1	1
Saw filer, power-driven	275.00	1	1	1	1	1	1	1	1	1	1

Estimated Requirements—Continued

Item	Aprox unit cost	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
Saw, circular, woodworking, 5 hp	$550.00	1	1	1	1	1	1	1	2	2	2
Shaper, woodworking, 2 hp	500.00	1	1	1	1	1	1	1	1	1	1
Shaper, woodworking, 5 hp	1,000.00										
PAINT SHOP											
Embossing machine	$100.00	1	1	1	1	1	1	1	1	1	1
Fan, ventilating, wall mtd., propeller type	35.00	1	1	1	1	1	1	1	1	1	1
Mixer, agitator type	150.00	1	1	1	1	1	1	1	1	1	1
Mixer, vibrator type, 2-5 gal. can capacity	150.00	1	1	1	1	1	1	1	1	1	1
Sander, disc, 7 in	30.00	1	1	1	1	1	1	1	1	1	1
Spray-painting outfit, portable, electric	400.00	1	1	1	1	1	1	1	1	1	1
Stencil cutting machine	150.00										

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Appendix II. GUIDE FOR HAND TOOLS AND MISCELLANEOUS EQUIPMENT

Number of civilian and military employees permanently assigned to the maintenance and operations organization, including preventive maintenance, custodial services, insect and rodent control, packing and crating.

Strength—(R & U)	----------	76 90	91 135	136 175	176 215	216 260	261 320	321 360	361 390	391 471	476 600
Building floor area (million square feet)											
Floor area (Installation)	----------	0.125– 0.25	0.25– 0.75	0.75– 1.25	1.25– 1.75	1.75– 2.5	2.5– 3.6	3.6– 4.7	4.7– 5.8	5.9– 9.0	9.0– 14.0
Installation military strength											
Strength—(Military)	----------	501– 1,000	1,001– 3,000	3,001– 5,000	5,001– 7,000	7,001– 10,000	10,001– 15,000	15,001– 20,000	20,001– 25,000	25,001– 40,000	40,001– 60,000
Estimated Requirements											
Item	Approx unit cost	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
ELECTRIC SHOP											
Bar, digging, 5½ ft. long with tamping head	$6.50	2	2	3	3	4	6	6	12	12	12
Bender set, tube, hand	1.50	1	1	1	1	1	1	2	2	2	2
Bit, expansive, ⅞ in. to 3 in.	3.50	1	1	1	1	2	2	2	2	2	2
Brace, ratchet, 8 in. swing	2.75	----------	----------	1	1	2	2	3	3	3	3
Brace, ratchet, 10 in. or 12 in. swing	3.75	1	1	2	2	3	3	4	4	4	4
Chisels, cold, set of 6: ⅜ in., ½ in., ⅝ in., ¾ in., ⅞ in. and 1 in.	4.50	1	1	1	1	2	2	3	4	4	4
Chisels, wood, socket-butt, blade 3¾ in. long, set of 4: ¼ in., ½ in., ¾ in., and 1 in.	2.50	2	2	3	4	4	6	6	12	12	12
Clamp, C, 6 in.	1.00	9	9	12	18	18	24	24	36	36	36
Cutter, bolt, 36 in. long, ⅝ in. cap	18.00	----------	----------	1	2	2	3	3	4	4	4
Cutter for copper, aluminum, brass, bundy steel and lead tubing.	3.00	1	1	2	2	3	4	4	5	5	5
Drill set for drilling with electric hammer in brick, stone, and marble. Kit consists of one steel holder and drill points, 3/16 in., ¼ in., 5/16 in., ⅜ in., 7/16 in., ½ in., ⅝ in., ¾ in.	11.50	1	1	1	1	1	1	2	4	4	4
Extractor, screw, ¼ in. to ⅝ in.	2.50	----------	----------	1	2	3	4	4	6	6	6
Fishwire, ⅛ in. x 1⅜ in., 100 ft. long	4.50	1	1	1	1	2	2	3	4	4	4

Estimated Requirements—Continued

Item	Approx unit cost	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
Frame, backsaw, adjustable, for 10 in. and 12 in. blade.	$1.50	1	1	1	2	2	2	3	3	3	3
Furnace, kerosene, with pump and shield	22.50				1	1	1	1	1	1	1
Hammer, claw, ripping	3.50	2	2	3	4	4	5	5	6	6	6
Iron, soldering, electric, medium	5.50	1	1	1	1	1	2	2	2	2	2
Iron, soldering, electric, heavy	8.50	1	1	1	2	2	3	3	4	4	4
Knife, lineman's	1.75	2	2	4	4	6	6	9	12	12	12
Ladle, soldering, melting, holds 1½ lb., 10 in. handle.	1.00	1	1	1	2	2	2	2	4	4	4
Micrometer, outside, ⅛ in. to 1 in.	9.25	1	1	1	1	1	1	2	2	2	2
Micrometer, outside, 1 in. – 2 in.	12.00	1	1	1	1	1	1	2	2	2	2
Pliers, diagonal, cutting 6 in.	2.50	1	2	2	4	4	4	5	6	6	6
Pliers, long-nose 6 in.	1.50	1	2	2	3	3	4	4	6	6	6
Pliers, side-cutting 8 in.	3.50	1	2	6	8	10	16	18	20	24	24
Pot, melting, 5 in. diameter, 12-lb. capacity	1.25			1	2	2	3	3	4	4	4
Saw, 26 in., 10 points to inch	7.75	3	3	4	6	6	9	9	12	12	12
Saw, keyhole, 10 in.	1.25	1	1	1	2	2	2	2	3	3	3
Screw driver, 6 in. nonconductor handle	1.00	3	3	4	6	6	9	9	12	12	12
Shovel, rplh or rpsh	4.50	2	2	3	4	4	6	6	8	8	8
Tape, steel, 50 ft.	5.75	1	1	1	1	1	2	2	2	2	2
Threader, ratchet for ½ in., 1¼ in. conduit	30.00	1	1	1	1	1	1	1	1	1	1
Torch, blow, 1-qt. capacity	13.25	1	1	1	2	2	2	3	3	3	3
Vise, combination bench and pipe vise, 5 in. jaw	55.00	1	1	1	1	1	2	2	2	2	2
Voltammeter, hookon 0–600 amperes, ac and 0–600 volts ac.	85.00					1	1	2	2	2	2
Voltmeter, ac 0–150–300–600	75.00					1	1	2	2	2	2
Wrench, adjustable, open-end ¾ in. capacity, 6 in. size.	1.00	2	2	3	4	4	6	6	8	8	8
Wrench, adjustable, open-end 1 5/16 in. capacity, 12-inch size.	2.25	2	2	3	4	4	6	6	8	8	8
Wrench, pipe, ¾ in. capacity 8 in. size	2.00	1	1	2	3	3	4	4	5	5	5
Wrench, pipe, 2 in. capacity 18 in. size	4.75	1	1	1	1	2	3	4	5	5	5
Wrench, pipe, 2½ in. capacity 24 in. size	8.00				1	1	1	2	2	2	2
Wrench, 12-point socket, set of 13, 3/16 in., ½ in., 9/16 in., 19/32 in., 5/8 in., 11/16 in., ¾ in., 25/32 in., 13/16 in., 7/8 in., 15/16 in., and 1 in.	90.00				1	1	1	1	2	2	2
REFRIGERATION AND AIR CONDITIONING SHOP											
Benders, set of six	$1.50	1	1	1	1	2	2	3	4	4	4
Charging block and gauges	7.50	1	1	1	1	2	2	3	4	4	4

Charging line, 36 in.	2.75	1	1	1	1	2	2	3	4	4	4
Clamps, hose, 3 at $0.10	.30	1	1	1	1	2	2	3	4	4	4
Cutter, tube	3.00	1	1	1	1	2	2	3	4	4	4
Detector, leak	1.50	1	1	1	1	2	2	3	4	4	4
File, mill, bastard, 10 in.	.80	1	1	1	1	2	2	3	4	4	4
File, flat, bastard, 10 in.	.50	1	1	1	1	2	2	3	4	4	4
File, round, bastard, 10 in.	.50	1	1	1	1	2	2	3	4	4	4
File, half round, bastard, 10 in.	.75	1	1	1	1	2	2	3	4	4	4
File, taper, extra slim, 5 in.	.40	1	1	1	1	2	2	3	4	4	4
Files, point, 3 at $0.30	.90	1	1	1	1	2	2	3	4	4	4
File, handles 2 at $0.20	.40	1	1	1	1	2	2	3	4	4	4
Flashlight, kits	4.00	1	1	1	1	2	2	3	4	4	4
Hammer, ball-peen, 12 oz.	2.00	1	1	1	1	2	2	3	4	4	4
Oiler, pistol type	2.25	1	1	1	1	2	2	3	4	4	4
Pliers, adjustable	1.25	1	1	1	1	2	2	3	4	4	4
Pliers, grip cut	2.00	1	1	1	1	2	2	3	4	4	4
Pliers, diagonal cutting, 6 in.	2.50	1	1	1	1	2	2	3	4	4	4
Pliers, needle nose, 6 in.	2.50	1	1	1	1	2	2	3	4	4	4
Pliers, fence, 10 in.	2.50	1	1	1	1	2	2	3	4	4	4
Plates, reaction, new style	.35	1	1	1	1	2	2	3	4	4	4
Presto-light tank, 10 cu. ft.	10.00	1	1	1	1	2	2	3	4	4	4
Puller, wheel	6.00	1	1	1	1	2	2	3	4	4	4
Pliers, small	1.75	1	1	1	1	2	2	3	4	4	4
Regulator, pressure, No. 10	5.00	1	1	1	1	2	2	3	4	4	4
Saw, key hole	1.25	1	1	1	1	2	2	3	4	4	4
Screw drivers, assortment	2.75	1	1	1	1	2	2	3	4	4	4
Screw driver, (Phillips), 3 in.	.75	1	1	1	1	2	2	3	4	4	4
Screw driver, (Phillips), 4 in.	1.00	1	1	1	1	2	2	3	4	4	4
Screw driver, (Phillips), 6 in.	1.25	1	1	1	1	2	2	3	4	4	4
Screw driver, (Phillips), 8 in.	1.50	1	1	1	1	2	2	3	4	4	4
Screw driver, offset	.50	1	1	1	1	2	2	3	4	4	4
Swedging tool, kit	7.25	1	1	1	1	2	2	3	4	4	4
Thermometer, pocket	2.00	1	1	1	1	2	2	3	4	4	4
Tool box	7.50	1	1	1	1	2	2	3	4	4	4
Tool, pinch off	2.15	1	1	1	1	2	2	3	4	4	4
Tool, flaring	7.75	1	1	1	1	2	2	3	4	4	4
Wrench, open end, 1/2 in. x 5/16 in.	.75	1	1	1	1	2	2	3	4	4	4
Wrench, open end, 11/32 in. x 13/16 in.	1.00	1	1	1	1	2	2	3	4	4	4
Wrench, open end, 3/8 in. x 3/4 in.	1.00	1	1	1	1	2	2	3	4	4	4
Wrench, open end, 23/32 in. x 13/16 in.	1.00	1	1	1	1	2	2	3	4	4	4
Wrench, open end 7/8 in. x 13/16 in.	1.25	1	1	1	1	2	2	3	4	4	4
Wrench, box	.75	1	1	1	1	2	2	3	4	4	4
Wrench, box	.90	1	1	1	1	2	2	3	4	4	4
Wrench, box	1.00	1	1	1	1	2	2	3	4	4	4
Wrench, adjustable, 1 in. capacity, 8 in. size	2.00	1	1	1	1	2	2	3	4	4	4
Wrench, adjustable, 1 1/2 in. capacity, 10 in. size	2.50	1	1	1	1	2	2	3	4	4	4
Wrench, pipe, 1 1/2 in. capacity, 14 in. size	1.75	1	1	1	1	2	2	3	4	4	4

Estimated Requirements—Continued

Item	Approx unit cost	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
Wrench, set, small	$4.00	1	1	1	1	2	2	3	4	4	4
Wrench, socket set, 18 pc	10.00	1	1	1	1	2	2	3	4	4	4
Wrench, key socket head screw (Allen) short	.75	1	1	1	1	2	2	3	4	4	4
Wrench, key socket head screw (Allen) long	1.00	1	1	1	1	2	2	3	4	4	4
HEATING SHOP											
Chisel, wood, 1 in.	$1.25	1	2	3	3	4	4	5	5	6	6
Chisel, cold, 1 in.	1.00	1	2	3	3	4	4	5	5	6	6
Chisel, half round, 5/8 in.	1.00	1	2	3	3	4	4	5	5	6	6
Extractor, nozzle	2.50	1	2	3	3	4	4	5	5	6	6
Flashlight	1.25	1	2	3	3	4	4	5	5	6	6
Flaring tools, 5/16 in. to 3/4 in.	4.00	1	2	3	3	4	4	5	5	6	6
Hammer, machinist, ball-peen, 1 lb.	2.25	1	2	3	3	4	4	5	5	6	6
Pliers, 8 in. slip joint	1.50	1	2	3	3	4	4	5	5	6	6
Pliers, 7 in. vice grip	1.25	1	2	3	3	4	4	5	5	6	6
Pliers, 10 in., vice grip	1.75	1	2	3	3	4	4	5	5	6	6
Pliers, 6 in., diagonal	2.50	1	2	3	3	4	4	5	5	6	6
Pliers, 6 in., long thin needle nose	1.50	1	2	3	3	4	4	5	5	6	6
Pliers, 10 in., multiple groove joint, utility	2.50	1	2	3	3	4	4	5	5	6	6
Pliers, 8 in. electrician side cutting	3.50	1	2	3	3	4	4	5	5	6	6
Punch, 1/8 in.	.50	1	2	3	3	4	4	5	5	6	6
Punch, 1/4 in.	.50	1	2	3	3	4	4	5	5	6	6
Punch, 3/16 in.	.60	1	2	3	3	4	4	5	5	6	6
Punch, center	.50	1	2	3	3	4	4	5	5	6	6
Rule, 72 in.	1.25	1	2	3	3	4	4	5	5	6	6
Saw, back, frame, adjustable, 10 in. to 12 in.	1.50	1	2	3	3	4	4	5	5	6	6
Screwdriver, 3/8 x 8 in. long shank	.80	1	2	3	3	4	4	5	5	6	6
Screwdriver, 5/16 x 6 in.	.60	1	2	3	3	4	4	5	5	6	6
Screwdriver, 3/8 x 10 in. long shank	1.00	1	2	3	3	4	4	5	5	6	6
Screwdriver, 5/16 x 8 in. long shank	.90	1	2	3	3	4	4	5	5	6	6
Screwdriver, (Phillips), 5/16 in. x 6 in. long shank	.60	1	2	3	3	4	4	5	5	6	6
Screw driver, (Phillips), 1/4 x 8 in. long shank	1.00	1	2	3	3	4	4	5	5	6	6
Wrench, adjustable, 6 in. size	1.75	1	2	3	3	4	4	5	5	6	6
Wrench, adjustable, 10 in. size	2.50	1	2	3	3	4	4	5	5	6	6
Wrenches, open end, 1/4 in. to 1 in. set	5.25	1	2	3	3	4	4	5	5	6	6
Wrenches, box end, 3/8 in. to 5/8 in., set	3.75	1	2	3	3	4	4	5	5	6	6
Wrench, pipe, 3/4 in. capacity, 8 in. size	2.00	1	2	3	3	4	4	5	5	6	6
Wrench, pipe, 1 in. capacity, 10 in. size	2.50	1	2	3	3	4	4	5	5	6	6
Wrench, pipe, 1 1/2 in. capacity, 14 in. size	3.25	1	2	3	3	4	4	5	5	6	6
Wrench, pipe, 2 in. capacity, 18 in. size	4.75	1	2	3	3	4	4	5	5	6	6
Voltage tester up to 230 volts	5.00	1	2	3	3	4	4	5	5	6	6

Voltmeter, portable, adjustable range	23.50	1	2	3	3	4	4	5	5	6	6
PLUMBING and STEAMFITTING SHOP											
Auger, flexible coil, wire, closet cleaner	$1.75	1	1	2	3	3	4	5	6	6	6
Auger, hook end clean out	1.00	1	1	1	2	2	2	3	3	3	3
Auger, sewer and pipe ½ in. x 50 ft	6.00	1	1	1	2	2	2	3	3	3	3
Auger, sewer and pipe ¾ in. x 100 ft	12.50	1	1	1	2	2	2	3	3	3	3
Bits, wood, assorted sizes	13.75	1	1	1	1	1	2	2	2	2	2
Brace, bit, ratchet 10 in. sweep	3.75	1	1	1	1	1	3	3	3	3	3
Chisel, cape, ¾ in.	1.25	1	1	2	3	3	4	6	10	12	12
Chisel, plumbers, cold, ½ in. x ¾ in. x 10 in.	.80	1	1	2	3	3	4	4	8	8	8
Chisel, plumbers, cold, ⅝ in. x 1 in. x 11 in.	.00	1	1	2	3	3	4	4	6	8	8
Chisel, plumbers, cold, ¾ in. x 1¼ in. x 11½ in.	1.00	1	1	2	3	3	4	4	6	8	8
Chisel, cold, ¾ in. x ⅞ in. x 7½ in.	1.00	1	1	2	2	2	3	4	6	6	6
Chisel, cold, 1 in. x 1¼ in. x 8½ in.	1.25	1	2	2	2	2	3	4	6	6	6
Chisel, diamond-point, ½ in. x ¾ in. x 7½ in.	1.00	1	2	2	3	3	4	4	6	8	8
Chisel, round-nose, ⅜ in. x ⅜ in. x 7 in.	.75	1	1	2	4	4	6	6	12	14	14
Chisel, wood, set of 5, ¼ in., ½ in., ¾ in., 1 in., 2 in. set.	6.00			1	1	1	2	2	3	3	3
Cup, force, 5½ in. diam	.35	2	2	3	4	4	6	8	10	12	12
Cutters, pipe, one-wheel ⅛ in. to 1 in. cut	6.00	2	2	2	4	4	6	8	10	12	12
Cutters, pipe, three-wheel, ⅛ in. to 2 in. cut	13.00	1	1	1	2	2	2	3	3	3	3
Cutter, pipe, automatic geared, 2 in. to 4 in.	92.00			1	1	1	1	2	2	2	2
Cutters, pipe, automatic geared, 4½ in. to 8 in.	212.00					1	1	2	2	2	2
Cutters, pipe, chain-type, 4 in.–12 in. cut	98.00					1	1	2	2	2	2
Dies with stock, set of 6, ⅛ in. to ¾ in.	21.00	1	1	1	1	1	2	2	4	6	6
Dies with stock, set of 6, ½ in. to 2 in.	24.00	1	1	1	2	2	2	3	4	6	6
Drills, twist, straight shank, 1/16 in. to ½ in. by 64ths, set.	10.00			1	2	2	3	4	6	8	8
File, flat, bastard, 10 in.	.80	1	1	2	3	3	4	6	8	12	12
File, half-round, bastard, 10 in.	.90	1	1	2	4	4	6	6	10	12	12
File, round, bastard, 10 in.	.60	1	1	2	4	4	6	6	10	12	12
File, square, tapered, bastard, 10 in.	.60	1	1	2	4	4	6	6	10	12	12
Flaring tool. Tube flaring tool in case, 3/16, 5/16, ¼, 5/16, ⅜, 7/16, ½, ⅝, ¾ inch.	7.75			1	1	1	1	1	1	1	1
Furnace, heavy-duty, 1 gal, capacity	20.00	1	1	1	2	2	2	3	3	4	4
Hammer, ball-peen 1 lb	2.25	1	1	2	3	3	4	4	6	8	8
Hammer, ball-peen 2 lb	2.50	1	1	2	3	3	4	4	6	8	8
Hammer, striking, 8 lb	5.00	1	1	1	2	2	2	3	3	4	4
Irons, packing and caulking (soil pipe) set of 2, ⅝ in. and ¾ in. x 7½ in.	3.00	1	1	1	2	2	2	3	3	4	4
Irons, packing and caulking (water main) set of 2, ⅜ in. and ⅞ in. x 8½ in.	4.00	1	1	1	2	2	2	3	3	4	4
Iron, soldering, electric, medium soldering, tip ⅝ in. and 1 in. tip.	5.50	1	1	1	1	1	2	3	4	4	4

Estimated Requirements—Continued

Item	Aprox unit cost	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
Iron, soldering, electric, heavy duty, tip diameter 1⅝ in.	$8.50	--------	--------	--------	1	1	1	1	1	1	1
Ladder, step, 6 ft	9.00	1	1	1	1	2	2	2	2	2	2
Ladder, step, 8 ft	12.00	--------	--------	1	1	2	2	2	2	2	2
Ladder, step, 10 ft	15.00	--------	--------	--------	1	1	2	2	2	2	2
Ladle, pouring, hot-metal, 3 in. diameter	.75	1	1	1	1	1	2	2	2	4	4
Level, utility, 24 in.	6.00	1	1	1	2	2	2	2	3	4	4
Pick, railroad, 7 lb, 24 in. long	3.00	1	1	3	4	4	6	8	10	12	12
Pliers, standard nose, 6 in.	.50	1	1	2	2	2	3	3	4	6	6
Pliers, gripping, 9 in.	1.00	1	1	2	2	2	3	3	4	6	6
Plumb bob, steel, 12 oz	.75	1	1	2	2	2	3	4	6	6	6
Pot, melting, cast iron, 5 in. diameter	1.25	1	1	1	2	2	2	2	3	4	4
Punch, center	.50	1	1	1	2	2	4	4	6	6	6
Rasp, flat, wood	1.50	1	1	2	4	4	6	6	10	12	12
Rule, 6 ft, folding	1.50	2	2	4	6	8	10	10	12	12	12
Runner, joint, with clamp for 2 in.–4 in. pipe	2.00	1	1	1	2	2	2	3	3	3	3
Runner, joint, with clamp for 4 in. to 6 in. pipe	2.50	1	1	1	1	1	2	2	2	2	2
Runner, joint, with clamp for 6 in. to 10 in. pipe	4.00	1	1	1	1	1	1	1	1	1	1
Saw, compass, 12 in blade	1.50	1	1	1	2	2	2	3	3	4	4
Saw, hack, frame, adjustable, 10 in. to 12 in.	1.50	1	1	1	2	2	2	4	6	8	8
Screw driver, 6 in. blade	1.00	1	1	2	3	3	3	3	6	6	6
Screw driver, 10 in. blade	1.00	1	1	1	2	3	4	4	6	6	6
Shovel, spade	4.50	1	2	3	4	5	6	6	7	8	8
Taps, pipe, set: ⅛ in., ¼ in., ⅜ in., ½ in., ¾ in., 1 in., 1¼ in., and 2 in.	28.50	1	1	1	1	1	1	1	1	1	1
Tongs, chain, 1 in. to 6 in. pipe	25.00	1	1	1	2	2	2	2	4	4	4
Tongs, chain, 1½ in. to 8 in. pipe	31.00	--------	--------	1	1	1	2	2	4	4	4
Torch, blow, 1-qt, capacity	11.00	1	1	1	2	2	3	3	4	4	4
Vise, pipe, ⅜ in. to 2½ in. cap	10.50	1	1	2	4	4	6	6	10	10	10
Vise, pipe, chain, ½ in. to 8 in. cap	20.00	1	1	1	2	2	3	4	4	4	4
Vise, combination bench and pipe vise, 5 in. jaw	55.00	1	1	1	2	3	3	4	4	5	5
Wrench, pipe, ½ in. capacity 6 in. size	1.50	1	1	2	4	5	6	8	10	12	12
Wrench, pipe, ¾ in. capacity, 8 in. size	2.00	1	1	2	4	5	6	8	10	12	12
Wrench, pipe, 1 in. capacity, 10 in. size	2.50	1	1	2	4	5	6	8	10	12	12
Wrench, pipe, 1½ in. capacity, 14 in. size	3.25	1	1	2	4	5	6	8	10	12	12
Wrench, pipe, 2 in. capacity, 18 in. size	4.75	--------	1	2	4	5	6	8	10	12	12
Wrench, pipe, 2½ in. capacity, 24 in. size	8.00	--------	--------	--------	4	4	4	6	6	8	8
Wrench, pipe, 3½ in. capacity, 36 in. size	15.00	--------	--------	--------	1	1	2	2	2	2	2
Wrench, pipe, 5 in. capacity, 48 in. size	22.50	--------	--------	--------	1	1	2	2	2	2	2
Wrench, closet, spud, 1¼ in.–2 in.	1.50	1	1	1	1	1	2	2	3	3	3
Wrench, closet, spud, 1½ in.–2 in.	1.50	1	1	1	1	1	2	2	3	3	3

(The following items are normally used in Sanitation Section activities):											
Cup, sand, 4 in.–12 in., set	$20.00	--------	--------	1	1	1	1	1	1	1	1
Frame, rod reel, holding	25.00	1	1	1	1	1	1	1	1	1	1
Head, spear	10.00	1	1	1	1	1	1	1	1	1	1
Plug, pipe, 4 in.–18 in., set	15.00	--------	--------	1	1	1	1	1	1	1	1
Stand, rod reel	20.00	1	1	1	1	1	1	1	1	1	1
Tool, assembly	4.00	2	2	2	2	2	2	2	2	2	2
Tool, pick-up	15.00	1	1	1	1	1	1	1	1	1	1
Tool, pull-out	12.00	1	1	1	2	2	2	2	2	2	2
METAL WORK SHOP											
(1) *Sheet metal*											
Awl, scratch, 3½-inch carbon steel blade, 3-in. hardwood handle.	$.75	1	1	1	2	2	2	2	4	4	4
Awl, piercing, 2½-in. blade w/hardwood handle	.75	1	1	1	2	2	2	2	4	4	4
Bit set, drill, metal, ⅛ to ½ inch by 16ths, with stand.	10.00	1	1	1	2	2	2	4	6	6	6
Chisel, cold, ⅜ in., 12 in. long	1.00	2	2	2	3	3	3	4	6	6	6
Chisel, cold, ¾ in., 12 in. long	1.00	2	2	2	3	3	3	4	6	6	6
Clamp, T, 6 in., medium	1.50	2	2	4	4	6	6	8	10	12	12
Coppers, soldering, pointed pattern, pr	1.50	2	2	4	4	4	6	8	10	10	10
Coppers, soldering flat bottom pattern, pr	5.00	2	2	2	2	4	4	6	8	8	8
Dividers, wing type, 12 in.	3.00	1	1	1	1	1	1	2	2	2	2
Fire pot, liquid fuel, 1 gal fuel reservoir	23.00	1	1	1	1	1	1	1	2	3	3
Frame, hack saw, adjustable 10 in. to 12 in. blade	1.50	1	1	1	2	2	4	4	6	6	6
Grooving tools, hand sizes, ⅛ in., ⅛ in., ⅜ in.	6.00	2	2	2	4	4	4	6	8	10	10
Hacksaw, rotary, 1 in. to 3½ in., ⅛in. graduations.	19.00	--------	--------	1	1	2	2	2	3	3	3
Hammer, raising, light	2.50	1	1	1	1	1	1	1	2	2	2
Hammer, raising, heavy	3.50	1	1	1	1	1	1	1	2	2	2
Hammer, riveting	2.25	1	1	1	3	3	3	4	6	6	6
Hammer, setting	2.25	1	1	1	1	1	1	1	2	2	2
Ladder, extension, 16 ft., sections	19.00	1	1	1	1	1	1	1	1	1	1
Ladder, step, 8 ft	12.00	1	1	1	1	1	1	2	2	2	2
Mallet, wood, w/handle, head 2½ in. x 4½in.	1.00	1	1	1	1	1	2	2	4	4	4
Mallett, hard rubber, 2½ in. x 4½ in. head, 11½ in. handle.	1.50	2	2	2	4	4	6	6	8	8	8
Nippers, cutting, 8 in.	3.00	1	1	1	1	1	1	1	1	1	1
Plate, bench, 37½ in. x 8 in., 54 lbs	20.00	1	1	1	1	1	1	1	2	2	2
Pliers, combination, 8 in.	1.50	1	1	1	1	1	1	2	3	3	3
Pliers, thin-nose 6 in.	1.50	1	1	1	3	3	3	4	6	6	6
Pliers, round nose, 6 in.	1.50	1	1	1	3	3	3	4	6	6	6
Punch, hand, 18 gauge capacity, ¼ in. hole	9.00	1	1	1	2	2	2	3	5	5	5
Punches, hollow, ⅜ in., ⅝ in., ½ in., ¾ in., set	6.00	1	1	1	1	1	1	2	2	2	2
Rivet set, 3 sizes, set	1.50	1	1	1	3	3	3	4	6	6	6

Estimated Requirements—Continued

Item	Approx unit cost	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
Rule, circumference, flexible 3 ft	$3.25	1	1	1	2	2	2	2	3	3	3
Scraper, roofing, 7 in. blade, weighted	7.25	1	1	2	2	2	2	2	4	4	4
Screw driver, plastic handle, 6 in	1.00	2	2	2	4	4	6	6	10	10	10
Seamer, Landy, 7¼ in. x 3½ in	5.00	1	1	1	3	3	3	3	6	6	6
Shears, slitting, hand, 13½ in. long	10.00	1	1	1	3	3	3	4	6	6	6
Slaters set: ripper, stake, hammer, punch, (1 each) set.	12.25				1	1	1	1	1	1	1
Snips, tinners, straight pattern, 9½ in	2.00	1	1	2	3	4	8	8	12	24	24
Snips, tinners, straight pattern, 15¾ in. long	7.00				1	1	2	3	4	6	6
Snips, tinners, aviation R and L 10½ in. long	2.75	1	1	1	1	2	2	2	3	3	3
Snips, tinners, hawks bill pattern, 11½ in	6.25	1	1	1	1	2	2	2	3	3	3
Stake, beakhorn-type	40.00	1	1	1	1	1	1	1	2	2	2
Stake, blowhorn	25.00	1	1	1	1	1	1	1	2	2	2
Stake, coppersmith's square	12.50	1	1	1	1	1	1	1	2	2	2
Stake, double-seaming	42.50	1	1	1	1	1	1	1	2	2	2
Stake, edge-bevel square	18.25	1	1	1	1	1	1	1	2	2	2
Stake, hatchet	14.50	1	1	1	1	1	1	1	2	2	2
Stake, hollow mandrel	50.00	1	1	1	1	1	1	2	3	3	3
Stake, mandrel	30.00	2	2	2	2	2	2	3	3	3	3
Stake, square	9.25	1	1	1	1	1	1	1	3	3	3
Square 24 in., stainless	4.75	2	2	2	2	2	2	2	2	3	3
Vise, steel, bench, 3 in. jaws, 4 in. opening	26.00	1	1	1	2	2	2	2	3	3	3
Wrench, adjustable, 1½ in. size, 10 in. long	2.00	1	2	2	3	4	5	6	6	8	8
(2) Welding											
Chisel, cape, ¼ in. x 4½ in., ⅜ in. x 6 in., set of two	$1.00	1	1	1	2	2	2	3	3	4	4
Chisel, cold, ½ in. x ¾ in. x 10 in	1.00	1	1	1	2	2	2	3	3	4	4
Chisel, cold, ⅝ in. x 1 in. x 11 in	1.00	1	1	1	2	2	2	3	3	4	4
Chisel, cold, ¾ in. x 1¼ in. x 11½ in	1.25	1	1	1	2	2	2	3	3	4	4
Chisel, diamond-point, ½ in. x ¾ in. x 7½ in	1.00	1	1	1	2	2	2	3	3	4	4
Chisel, round-nose ⅜ in. x ⅜ in. x 7 in	.75	1	1	1	2	2	2	3	3	4	4
File, flat, bastard, 10 in	.50	1	1	1	2	2	2	3	3	4	4
File, round, bastard, 10 in	.50	1	1	1	2	2	2	3	3	4	4
File, half round, bastard, 10 in	.75	1	1	1	2	2	2	3	3	4	4
File, square, tapered, bastard, 10 in	.50	1	1	1	2	2	2	3	3	4	4
Gloves, welding and cutting, pair	5.00	1	1	1	2	2	2	3	3	4	4
Goggles, welders, all-purpose	2.50	1	1	1	2	2	2	3	3	4	4
Hammer, ball-peen, 1 lb	1.25	1	1	1	2	2	2	3	3	4	4
Hammer, ball-peen, 2½ lb	1.50	1	1	1	2	2	2	3	3	4	4
Helmet, welders	5.00	1	1	1	2	2	2	2	2	3	3
Holders, electrode	3.50	1	1	1	2	2	2	2	2	3	3
Pliers, standard nose, 6 in	.50	1	1	1	2	2	2	3	3	4	4
Pliers, gripping, 7 in	2.00	1	1	1	2	2	2	3	3	4	4

Punch, center	.25	1	1	1	2	2	2	3	3	4	4
Rule, tape, steel, 6 ft., in case	2.00	1	1	1	2	2	2	2	2	3	3
Saw, hack, frame, adjustable, 10 in. to 12 in.	1.25	1	1	1	2	2	2	3	3	4	4
Screw driver, 6 in.	.25	1	1	1	2	2	2	3	3	4	4
Screw driver, 10 in.	.50	1	1	1	2	2	2	3	3	4	4
Sleeves, safety, pr.	3.00	1	1	1	2	2	2	3	3	4	4
(3) *Machine*											
Bar, pinch, crow, 5 ft.	4.25	1	1	2	2	4	4	6	6	6	6
Caliper, inside and outside, two sets, 4 in., 6 in., spring set	7.25	1	1	1	1	2	2	2	2	2	2
Caliper, outside, micrometer set of four, 0–1 in., 1 in.–2 in., 2 in.–3 in., 3 in.–4 in.	51.50					1	1	1	1	1	1
Caliper, pocket, slide, 5 in.	3.25	1	1	1	1	2	2	2	2	2	2
Chisel and punch set, six items, cape, cold, diamond point, round nose chisels, center point punches.	3.25	1	1	1	1	2	2	4	6	6	6
Chisel, cold, blacksmith, 1½ in., 3 lb.	3.00	1	1	1	1	2	2	2	4	6	6
Chisel, hot, blacksmith, 1½ in., 3 lb.	3.00	1	1	1	1	1	2	2	4	6	6
Clamp, C, medium wt., set of four, 4 in., 6 in., 8 in., 10 in.	12.75	1	2	2	3	4	6	8	10	12	12
Cutter, bar, hand operated to cut ¼ in. round and 1 in. x ¼ in. flats.	80.00	1	1	1	1	1	1	1	2	2	2
Cutter, bolt, ⅝ in. size, 36 in. long, rigid, clipper style.	18.00	1	1	1	1	1	1	1	2	2	2
Dividers, spring, 6 in.	6.25	1	1	1	1	2	2	2	4	4	4
Drill, twist, high speed steel, straight shank, set of 29 items, 1/16 in. to ½ in. by 64ths, in indexed box, set.	29.00	1	1	1	2	2	2	3	3	3	3
Drill, twist, high speed steel standard (Morse) taper shank, set of 32 items, 3/64 in. to 1 in. by 64ths, in indexed box, set.	75.00	1	1	1	1	1	1	1	1	1	1
File, flat, bastard, slightly tapered, cut on both edges and sides, 4 items, 6 in., 8 in., 10 in., 12 in., set.	2.75	12	12	12	18	18	24	24	24	24	24
File, flat, second cut, slightly tapered, cut on both edges and sides 3 items 6 in., 8 in., 10 in., set.	2.00	12	12	12	18	18	21	21	24	21	24
File, flat, smooth, slightly tapered, cut on both edges and sides 3 items, 6 in., 8 in., 14 in. set.	2.25	6	6	6	6	12	12	12	12	12	12
File, half round, bastard, tapered slightly, 12 in.	1.25	12	12	12	18	18	24	24	24	24	24
File, round, second cut or smooth, 12 in.	1.25	6	6	6	6	12	12	12	12	12	12
File, round, bastard, double cut, tapered, three items, 6 in., 10 in., 14 in., set.	2.25	6	6	6	6	12	12	12	12	12	12
File, round, second cut or smooth, single cut 3 items, 6 in., 8 in., 10 in. set.	2.00	6	6	6	6	12	12	12	12	12	12
File, square, bastard, double cut, 14 in.	1.00	6	6	6	6	12	12	12	12	12	12
File, square, smooth cut, 8 in.	.75	6	6	6	6	12	12	12	12	12	12
File, triangular, slim taper, second cut, 8 in.	.75	6	6	6	6	12	12	12	12	12	12

Estimated Requirements—Continued

Item	Approximate unit cost	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
Flatter, square, set of 2, 2 in., 4 in. set	$18.00	1	1	1	1	1	1	1	2	2	2
Fuller, top and bottom, two sets of five ¼ in., ⅜ in., ½ in., ¾ in., 1 in. set.	31.00	1	1	1	1	1	1	1	2	2	2
Gauge, center, spring tempered	1.00	--------	--------	--------	--------	3	3	3	3	3	3
Gauge, surface, universal, 3 in. base with 9 in. spindle.	7.00	--------	--------	--------	--------	1	1	1	1	1	1
Gauge, screw pitch, V thread 9 to 40 threads per inch, (including 11½ and 27 pipe threads).	4.60	1	1	1	1	1	1	1	1	1	1
Gauge, thickness, (.0015 to .025 in.) 3¼ in. long	2.50	1	1	1	1	1	1	1	1	1	1
Goggles, chippers and grinders safety goggles	2.50	3	3	4	4	6	8	10	12	12	12
Hammer, machinist	2.00	1	1	1	2	2	3	3	4	5	5
Hammer, cross-peen 2½ lb.	2.00	1	1	1	1	1	2	3	4	5	5
Hammer, riveting, tinners, 4 oz.	2.00	1	1	1	1	1	2	3	4	5	5
Hammer, with inserted faces protect working surfaces, 1 in. face.	2.25	1	1	1	1	2	3	4	5	6	6
Hammer, setting, 1½ in. size	3.50	1	1	1	1	1	2	3	4	4	4
Hardy, regular ⅝ in. square shank, 1 in. wide bit	2.50	1	1	1	1	1	2	3	4	4	4
Iron, soldering, electric	5.50	1	1	1	1	2	2	2	2	2	2
Jack, set of 3, 10-ton, 15-ton and 25-ton, set	100.00	1	1	1	1	2	2	3	3	3	3
Light, trouble, 25 ft	3.00	1	1	1	1	1	1	1	1	1	1
Maul, 5 lb.	4.50	1	1	1	1	1	2	2	3	3	4
Nippers, end, 14 in. cutting	2.25	1	1	1	1	1	2	2	4	4	4
Pliers, combination, slip joint, wire cutting, 10 in. long.	1.25	1	1	2	2	3	3	4	4	5	5
Pliers, diagonal, cutting, 7½ in. long	2.50	1	1	2	2	3	3	4	4	5	5
Pliers, long needle nose, 6½ in.	1.50	1	1	1	2	2	3	3	4	4	4
Punch, round, set of seven, ⅛ in., ⅜ in., ½ in., ⅝ in., ¾ in., ⅞ in., 1 in. set.	3.50	1	1	1	1	1	2	2	4	4	4
Rule, machinist, steel, 6 in. length	1.75	1	1	1	2	2	3	3	4	4	4
Rule, machinist, steel, 12 in. length	3.25	1	1	1	1	1	2	2	3	3	3
Rule, tape, steel, pull-push in chromium or nickel plated case.	2.50	1	1	1	1	2	2	3	3	4	4
Saw, hack, frame, adjustable, for 10-12 in. blade	1.50	1	1	1	1	2	3	3	4	4	4
Screw driver, single grip, plastic handle, 5 bits, 3 x ⅛, 4 x ¼, 6 x ⅜, 8 x ⅜, 10 x ⅜, 12 x ⅜.	3.25	1	1	1	1	2	2	2	3	3	3
Screw driver, offset, two items, 4 in., 8 in. set	2.00	1	1	1	1	1	1	1	1	2	2
Scriber, machinist, pocket style, single point	3.90	1	1	1	1	2	2	2	3	3	3
Sledge, double-faced, 8 lb.	3.00	--------	--------	--------	1	1	2	2	3	3	3
Sledge, cross-peen, 10 lb.	7.00	1	1	1	1	1	2	2	3	3	4
Square, carpenter, steel, one piece 16 in. x 24 in.	4.75	1	1	1	1	1	1	1	2	2	2
Tap and die, set, 33 items ⅛ in. No. 12, 64-24 threads per inch, set.	11.00	1	1	1	1	1	1	1	2	2	2

Tap and die, set, 65 items, ¼ in.-1 in., 28-8 threads per inch, set.	49.00	1	1	1	1	1	1	1	2	[illegible]	2
Tong, straight-lip, square, set of three, 16 in. x ¼ in., 16 in. x ⅜ in., 20 in. x ½ in., set.	12.00	1	1	1	1	1	1	1	2	3	[illegible]
Tong, curved-lip, fluted jaw, set of three: 18 in. x ¼ in., 20 in. x ⅜ in., 22 in. x ⅜ in., set.	14.00	1	1	1	1	1	1	1	2	2	2
Tong, rivet, set of four, 18 in., 20 in., 22 in., 24 in., set.	24.00	1	1	1	1	1	1	1	2	2	2
Torch, gasoline, blow, 1 qt	10.00	1	1	1	1	1	1	2	2	3	3
Vise, machinist, bench, swivel base, swivel jaw, 6 in. jaw, 9½ in. opening.	50.00	1	1	1	1	1	2	2	2	3	3
Wrench, adjustable, pipe, steel handle, set of 5 items, 6 in., 10 in., 14 in., 18 in., 24 in., size, set.	16.00	1	1	1	1	1	1	2	2	3	3
Wrench, monkey, 10 in. size	2.50	1	1	1	2	3	4	5	6	6	6
Wrench, socket, various sizes	20.00	1	1	1	1	1	1	1	1	1	1
Wrench, key socket head screw, (Allen) [illegible] items	2.50	1	1	1	1	1	1	1	1	2	[illegible]
Wrench, S shape, Drop-forged, ¼ in. to 1 in. capacity, ⅛ in. graduations, seven items.	7.50	1	1	1	1	1	1	1	1	2	3
MOBILE EQUIPMENT SHOP											
Cutter, bolt, 9/16 in. capacity, 36 in. long	$13.00	1	1	1	1	1	1	1	1	1	1
File, flat, bastard, 6 in., 8 in., 10 in., 12 in., set	2.00	1	1	1	2	2	2	3	3	4	4
File, flat, second cut, 6 in., 8 in., 10 in. set	1.50	1	1	1	2	2	2	3	3	4	4
File, flat, smooth, 6 in., 8 in., 14 in. set	2.25	1	1	1	2	2	2	3	3	4	4
File, half round, 12 in.	1.00	1	1	1	2	2	2	3	3	4	4
File, round, double cut, 6 in., 10 in., 14 in.	1.50	1	1	1	2	2	2	3	3	4	4
File, round, second cut, 6 in., 8 in., 10 in., set	1.25	1	1	1	2	2	2	3	3	4	4
File, square, bastard, double cut, 14 in.	1.00	1	1	1	2	2	2	3	3	4	4
Hydrometer, antifreeze solution tester	4.25	1	1	1	1	1	1	1	1	1	1
Light, trouble, 50 ft	1.75	1	1	1	1	1	1	1	1	1	1
Mechanics set of tools for each mechanic having portable bench with drawers.	150.00	1	1	1	2	2	2	3	3	4	4
Saw, hack, frame, adjustable, 10 in. to 12 in. blade.	1.25	1	1	1	1	2	2	2	2	2	2
Wrench, 12-point socket set of 13 sizes: 7/16 in., ½ in., 9/16 in., 19/32 in., 5/8 in., 11/16 in., ¾ in., 23/32 in., 13/16 in., 7/8 in., 15/16 in., 15/32 in. and 1 in.	30.00	1	1	1	1	1	1	1	1	1	1
WOODWORKING SHOP											
Adze, carpenters, handled, 3½ in. cut	$4.75	1	1	2	3	4	6	8	10	12	12
Axe, handled, single-bit, 3½ lb., 36 in. handle	4.75	1	1	2	3	4	6	8	10	12	12
Bar, crow, pinch-point, steel, 4 ft. long	3.25	1	1	1	1	2	2	2	5	5	5
Bar, crow, pinch-point, steel, 5 ft. long	6.50	1	1	1	1	2	2	2	5	5	5
Bar, wrecking, ⅝ in. diameter, 18 in. long, nail and prying end.	1.25	1	2	4	6	7	9	11	14	16	[illegible]

Estimated Requirements—Continued

Item	Approx unit cost	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
Bar, wrecking, ⅝ in. diameter, 30 in. long, nail and prying end.	$1.75	1	2	4	6	7	9	11	14	16	18
Bit set, auger, woodboring, ¼ to 1 inch by 16ths, in box.	13.00	1	1	1	2	2	3	4	6	6	6
Bit set, drill wood or metal, ⅛ to ½ inch by 64th with case.	4.00	5	5	5	10	10	10	15	15	15	15
Bit, expansive, ½ to 3 inch capacity	3.75	1	1	2	4	6	8	8	10	10	10
Blades, band-saw, set of 6: one ¼ in., two ½ in., two ¾ in., and one 1 in. wide.	20.00	----------	----------	----------	1	1	2	2	3	3	3
Blades, circular-saw 16 in. diameter, rip, set of 2; 30 and 36 teeth.	14.00	1	1	2	3	3	4	4	6	6	6
Blade, circular-saw 14 in. diameter, combination rip and crosscut.	6.00	2	2	2	4	4	4	4	4	4	4
Blade, circular-saw, 9 in. diameter, crosscut or rip.	8.50	2	2	2	4	4	4	4	4	4	4
Box, miter, with 26 x 4 inch back saw	36.00	----------	----------	1	1	1	2	3	4	4	4
Brace, ratchet, 10 in. swing	6.25	1	2	4	4	4	6	8	10	10	10
Chisels, carving, set of 6	4.00	----------	----------	----------	----------	1	2	3	4	6	6
Chisels, wood, socket set: ¼ in., ½ in., ¾ in., 1 in., 1½ in., and 2 in.	18.00	1	1	1	2	2	4	4	6	8	8
Chisels, wood, half-round, ½ in. to 1 in. set of 8	15.00	----------	1	1	1	2	2	4	6	6	6
Clamp, bar, steel, 6 ft.-0 in. opening	5.50	2	2	6	8	8	10	10	12	12	12
Clamp, C, body, 6 in. capacity, light service	2.50	4	4	6	6	10	12	16	18	18	18
Clamp, C, body, 8 in. capacity, light service	3.50	4	4	6	6	10	12	16	18	18	18
Clamp, C, body, 10 in. capacity	4.75	----------	----------	----------	----------	6	6	10	12	12	12
Clamp, bar, steel, 3 ft.-0 in. opening	4.00	----------	----------	1	2	2	3	4	6	6	6
Countersink, ¼-in. or ⅜-in. diameter and 6 in. or 7 in. long.	.50	1	2	2	2	6	10	12	12	16	16
Cutter, glass	1.00	2	2	4	4	6	6	8	12	24	24
Dividers, wing-type	3.00	1	1	2	4	6	8	8	10	12	12
Drill, two-speed breast, for straight round shank bits up to ½ in.	20.00	----------	1	1	2	2	4	4	6	6	6
Drill, hand with crank driven gears. Drills up to ⅜ in.	10.00	1	2	2	4	4	6	8	10	10	10
Drill, Star, hand set of ¼ in., 5/16 in., ⅜ in., 7/16 in., ½ in., ⅝ in., ¾ in., 1 in.	10.00	1	2	2	4	4	6	8	10	10	10
File, half-round, bastard, second cut or smooth, 10 in.	1.00	1	1	2	4	6	8	12	18	20	20
File, hand saw, 6 in.	.75	1	1	2	4	6	8	12	18	20	20
File, half round, bastard, 12 in.	1.25	1	1	2	4	6	8	12	18	20	20
File, mill, 1 round edge, 6 in.	.75	1	1	2	4	6	8	12	18	20	20
File, mill, 1 round edge, 12 in.	.75	1	1	2	4	6	8	12	18	20	20
File, round, bastard, 12 in.	.75	1	2	2	4	6	8	12	18	20	20

File, band-saw, blunt 8 in.	.75				4	6	8	12	18	20	20
Glue pot, 2-qt, 110-V	45.00				1	1	1	1	1	1	1
Hammer, claw, 16-oz	3.75	5	5	10	20	20	30	40	60	60	60
Hatchet, claw, 3½ in. cut	2.75	5	5	10	20	20	30	40	60	60	60
Jack, screw, 15-ton	8.00	2	2	2	4	4	4	4	8	8	8
Knife, draw, 10 in.	2.25	1	1	2	4	4	5	6	8	8	8
Level, carpenter, plumb and level, aluminum, 24 in.	5.00	1	1	4	6	12	18	24	30	30	30
Nail set, square-head, ⅛ in., 4 in. long	.25	5	5	10	20	20	30	40	60	60	60
Pincers, carpenters, cutting, 10 in.	2.00	3	3	6	6	12	15	18	24	24	24
Plane, 5½ in. block with 1¾ in. bit	2.00	1	1	2	2	4	6	8	10	10	10
Plane, 8 in. smooth, 1¾ in. bit	6.00	1	1	2	2	4	6	8	10	10	10
Plane, 18 in., jack, 2⅜ in. bit	12.50	1	1	2	2	4	6	8	10	10	10
Plane, rabbet, 1⅞ in. skewcutter	10.00	1	1	1	2	2	4	6	8	8	8
Pliers, common slip joint, 6 in.	1.25	3	3	6	6	12	15	18	24	24	24
Rasp, half-round, wood, 12 in.	1.50	2	6	8	12	18	24	24	30	30	30
Rule, wood, 6-foot, folding extension with slide	1.75	5	5	10	20	20	30	40	60	60	60
Rule, 4-fold, 2-foot	1.00	2	3	6	8	10	12	16	18	20	20
Saw, compass, 12 in. blade	1.50	2	3	4	6	8	10	14	18	20	20
Saw, coping, 5 in. blade	1.25	1	2	4	6	8	12	16	18	20	20
Saw, hand, crosscut, 26 in., 10 points to inch	6.00	1	1	1	2	4	6	8	10	10	10
Saw, hand, crosscut, 26 in., 8 points to inch	6.00	5	5	5	10	10	15	20	30	30	30
Saw, hand, rip, 26 in., 5½ points to inch	6.00	5	5	5	10	10	15	20	30	30	30
Saw filer, hand	8.00	1	1	1	2	2	2	2	2	2	2
Scraper, hand, for paint, etc	1.00	1	2	5	10	10	15	20	30	30	30
Screwdriver, wood handle, 6 x ⅜ in.	.75	2	4	4	6	6	10	10	15	15	15
Screwdriver, wood handle, 10 x ⅜ in.	1.25	2	4	4	6	6	10	10	15	15	15
Screwdriver, ratchet, 20 in.	7.00	1	1	2	3	4	6	8	10	12	12
Shears, tinners, 11½ in.	2.75	2	4	4	6	6	10	10	15	15	15
Square, bevel T, 10 in.	2.00	1	2	3	5	8	12	18	20	24	24
Square, combination, 12 in. steel blade	1.25	1	2	4	6	6	10	10	15	15	15
Square, framing, body 24 in. x 2 in., tongue 16 in. x 1½ in.	4.75	2	3	4	9	9	18	24	30	30	30
Stone, sharpening, mounted 1 x 2 x 7 in.	1.50	2	4	4	9	9	18	24	30	30	30
Vise, bench, clamp-base type	2.25	1	1	3	4	6	8	10	12	15	15
Vise, rapid-acting jaws, 4 in. x 10 in., 12 in. jaw opening,	16.00	1	1	3	4	6	8	10	12	15	15
Wrench, adjustable, 1½ in. capacity, 10 in. size	2.50	1	1	2	2	4	8	12	16	20	20
PAINT SHOP											
Gun, calking, all-metal, trigger-operated, holds 1 pt.	$2.75	1	1	2	4	6	7	8	10	12	12
Jack, ladder, rail-clamp type	12.00	6	6	10	12	14	16	18	20	20	20
Hammer, claw, ripping	3.75	1	1	1	1	2	2	2	3	3	3
Knife, putty, 1¾ in. x 3 in. blade, 7½ in. long	.75	2	3	5	10	12	16	18	20	24	24
Ladder, step, 4 ft., wood	7.50	1	1	2	4	6	6	6	8	10	10

Estimated Requirements—Continued

Item	Approx unit cost	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
Ladder, step, 6 ft., wood	$9.00				4	6	6	6	8	10	10
Ladder, step, 8 ft., wood	12.00	1	1	2	4	6	6	6	8	10	10
Ladder, step, 12 ft., wood	27.00			1	1	4	6	6	6	10	10
Ladder, extension 24 ft., 2-section, wood	24.00	1	1	2	4	6	6	6	8	10	10
Ladder, extension 30 ft., 2-section, wood	30.00			1	2	3	4	6	8	10	10
Ladder, extension, 40 ft., 2-section	40.00				1	2	4	6	8	10	10
Plank, extension, 6 ft., extending to 10 ft. 6 in.	10.00	1	1	2	4	6	8	10	12	12	12
Pliers, standard nose, 6 in.	1.50	1	1	1	1	2	2	2	3	3	3
Respirator, paint spray, with filters	6.00				4	6	8	10	12	12	12
Saw, hand, cross-cut, 26 in., 8 point to inch	6.00	1	1	1	1	2	2	2	2	2	2
Scraper, hand, 2½ in. wide, 5 in. overall length	1.50	2	3	5	10	12	16	18	20	20	20
Stage, swing, 24 ft.	48.00				1	1	1	1	2	2	2
Stencil cutting machine, 1⅜ in. letters	500.00								1	1	1
Stencil cutting machine, ⅞ in. letters	225.00				1	1	1	1	1	1	1
Stencil duplicating print kit	20.00	1	1	1	1	1	1	1	1	1	1
Torch, blow, 1 quart capacity	10.50	1	1	1	2	3	4	6	8	10	12
Trestle, extensions, 6 ft., extending to 10 ft., wood, pair.	50.00			2	2	4	6	8	10	12	14
Trestle, extensions, 10 ft., extending to 18 ft., wood, pair.	100.00				2	2	4	4	6	6	6

Appendix 6

MEMORANDUM

TO: Dr. E. Croft Long
Chief, Public Health Division
USAID/Guatemala

DATE: November 18, 1977

FROM: John Donahue
Regional Advisor for Health Facilities Maintenance
Pan American Health Organization
Washington, D.C.

SUBJECT: Critique of HSA Health Facilities Maintenance Chapter and Annex

This memo is to be considered a formal PAHO review of the USAID/G HSA health facility maintenance Chapter and Annex.

At the onset I would state that the document does indeed identify the problem and workable solutions; more important is the possible application to other developing countries, not only in the Americas but the Asian/African as a pilot program.

The document addresses well the two basic questions: "who will train?" and "who is to do the maintenance service on a day to day basis?"

With respect to training, I support and recommend that INTECAP (Instituto Técnico de Capacitación y Productividad) be contracted for the following reasons:

1. They have the required teaching staff
2. They have the interest and the experience in vocational training.
3. They have been conducting courses in general maintenance
4. They have the enthusiasm

5. There appears to be no other agency that could perform with equal effectiveness.

With respect to maintenance service, I support the recommendation that INTECAP be contracted to provide services until such time as the Ministry of Health has a trained Engineering and Maintenance staff at the national and at the two-sub-regional levels. My reasons for supporting this approach are:

1. 80% of the training time should be away from the classroom in practical application exercise.
2. Presently the technical capability in health facilities does not exist, therefore, this would give the teacher and students a chance to investigate and solve problems with hand-on-application and at the same time be furnishing a service.
3. The health facilities would be receiving a concerted effort to alleviate some of the problems now.
4. It will take the MOH two years or more to develop a staff but less for INTECAP to initiate a program.
5. It would give INTECAP first hand experience that should result in better curriculum application/development, more experience for the teacher and an insight to the area of maintenance for applications to industry and other government agencies.

Although the concept of a training institution being contracted to do the maintenance service is not the traditional approach, I

believe it is sound for the reasons stated above and the experience of other Latin American countries. PAHO experience in Latin America is such that the concept is at least warrants investigation.

As the Regional Advisor in the Americas for health facilities maintenance and engineering, I have had the opportunity to work with all the countries in the Americas. Within the last 10 years, 50% have developed a National Maintenance Policy, Division of Engineering and Maintenance at the Ministerial level with qualified engineers directing the program and 25% of the countries now have training centers in operation, under construction or funded and approved for construction. The provision of training and service varies from country to country. However, the basis underlying principle to a successful program appears to be keeping training and services in the same agency or organization. For this reason, I believe that INTECAP could successfully train maintenance personnel and provide maintenance services.

To initiate the program recommended in Annex 5.11, the following sequence of action is recommended:

1. The government, by legislation, should enact into law a national policy for maintenance. (Venezuela has enacted such a policy).
2. The Ministry of Health should develop an appropriate program identifying the "Division of Engineering and Maintenance" and budget. At full operation an expected annual cost of

the total system of maintenance for the entire country will be approximately 15 million dollars.

3. Formal agreements should be made between the MOH and the Ministry of Labor (INTECAP) to train operators and technicians in the area of maintenance and to operate the three proposed training centers for the first five years or until such time as the MOH has an established operational capability.
4. INTECAP should be given ten academic fellowships for graduate studies in maintenance.
5. The MOH should counter its losses of trained individuals for the Health Sector by making a concerted effort in meaningful fiscal and management reform in the national health system for job retention or placement.
6. AID should consider financing a hospital engineer post now to assist in the development of Recommendations 1-5 above.
7. As the Recommendations above are being completed, Peace Corps participation should be formulated and projected to commence when Recommendations 1-4 have been completed. There could be exceptions to early Peace Corps participation but this should be determined by the AID engineer (Recommendation 6).

8. During the period of development of Recommendations 1-7, training facilities design, construction and training equipment should be instigated but actual monetary expenditures should not take place until the AID engineer feels that the government has proceeded to the point that the overall project success is assured.

In conclusion, I would like to again call attention to the Venezuela program. After 10 years of development, the MOH through its Department of Engineering and Maintenance now operates its own programs of training and maintenance for all health facilities in the country and receives trainees from other countries. In 1977 over 2,000 technicians were graduated and over 6,000 have been trained since the program inception. No further outside expertise is required. This, I believe, possible in Guatemala.