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FEASIBILITY STUDY FOR A TWO-WAY RADIO SYSTEM FOR INTEGRATED RURAL HEALTH SERVICES IN ECUADOR

A REPORT TO USAID/QUITO, ECUADOR

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April, 1982

Prepared by the Academy for Educational Development, Washington, D.C. under contract ta-C-1473 with ST/ED, AID, Washington, D.C.

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INTRODUCTION

This is a report to USAID/Quito on a mission to Ecuador to assess the feasibility of establishing two way radio communication systems in two sections of the country. The systems would be dedicated to serving the needs of the health sector in the Jipijapa and Quimiag integrated rural development areas.

The report consists of two parts. Part I deals with the applications aspects of establishing the system: the uses to which the systems would be put and their relationship to the health delivery system and health problems in the areas. Part II is an engineering analysis, based on assumptions concerning the ideal paths for communication and which specific sites within the general areas will be served. These assumptions must be corroborated by additional engineering study, based on detailed topographical maps and by USAID/Quito with the Ministry of Health, before more refined estimates as to costs can be made.

A draft version of Part II of the report was left with USAID/Quito on departure of the engineering consultant. His cost estimates were subsequently reviewed and revised by Morcom's home office in Washington, D.C. The cost estimates in the present version reflect these revisions.

Based on the revised cost estimates submitted by Morcom, the Academy has prepared the following summary tables to present in simplified form the essential decision options for USAID/Quito and the Ecuadorean Ministry of Health. These options are based on a system having 24 hour reliability, which is a criterion set by the Ministry. If USAID and the Ministry wish to consider a system which has considerably lower reliability, i.e., good communication primarily in the early morning and late afternoon, the Academy is prepared to submit cost options for an HF (short wave) system.

The tables 1-A and 1-B below show the equipment costs for each project area for both a "full network," including all elements of the health delivery system, and for "priority" sites, as suggested by field workers in the two areas (lists can be found in Part I, Section 3.6).

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The tables 2-A and 2-B show engineering options. The more expensive option 1 is for USAID to contract with a U.S.-based engineering firm to handle all phases of procurement through local installation. This option is perhaps the easiest from a managerial point of view and lodges total responsibility in a single contractor. However, based on experience in other settings, the Academy believes that it would be possible to lower engineering costs dramatically, through an arrangement that would lodge engineering responsibility in an individual consultant, who would identify and arrange to contract lower cost Ecuadorean assistance, both technical and unskilled. USAID could either contract directly under this option or run it through a U.S. consulting firm, such as the Academy, which would add approximately 10 person days of management support, plus its usual indirect costs (approximately 26 per cent). Thus the total might be increased as follows:

Option 2 total	$15,610
10 days management	1,875
Subtotal	$17,485
26% Indirect Costs	4,546
New Total	$22,031

Table 1-A

EQUIPMENT COSTS

Quimiag:

Option 1: Full Network

Riobamba Hospital	$ 875
Quimiag Control Center	4,975
Riobamba Health Center	4,350
3 Health Subcenters at $4470	13,410
12 Health Posts @ $4470	53,640
1 Repeater @ $9815	9,815
	$87,065
Spares @ 15%	13,060
	$100,125
	[Plus shipping (5000 lb.)]

Option 2: Priority Sites

Riobamba Health Center	$ 4,350
3 Health Subcenters @ $4470	13,410
9 Health Posts @ $4470	40,230
1 Repeater @ $9815	9,815
	$ 67,805
Spares @ 15%	10,171
	$ 77,976
	(Plus shipping)

Table 1-B

EQUIPMENT COSTS

Jipijapa:

Option 1: Full Network

Jipijapa Hospital	$ 4,150
Jipijapa Control Center	4,975
8 Health Subcenters @ $4470	35,760
5 Health Posts @ $4470	22,350
3 System repeaters @ $9815	29,445
	$ 96,680
Spares @ 15%	14,502
	$111,182
	[Plus shipping (5000 lbs.)]

Option 2: Priority Sites

Jipijapa Hospital	$ 4,150
8 Health Subcenters @ $4470	35,760
2 Health posts @ $4470	8,940
3 System repeaters @ $9815	29,445
	$ 78,295
Spares @ 15%	11,744
	$ 90,039
	(Plus shipping)

Table 2-A

Engineering Options: Per Region

Option 1: Engineering, Procurement, Installation, by U.S. firm

Installation Labor (Estimated local labor @ 9 man-days/site x 19 +20 man-days/travel= 191 man-days) @ $250/day	$ 47,750
Test Equipment Rental and tools	4,000
System Engineering (map studies, path profiles, block diagrams, detailed system specification) 60 man-days @ $300/day	18,000
Equipment Engineering (detailed equipment specification and procurement monitoring) 30 man-days @$300/day	9,000
Supervision (in-country) 80 man-days	24,000
Per diem @ $80/day	6,400
Travel and Misc.	1,500
GRAND TOTAL	$ 110,650

Table 2-B

Engineering Options: Per Region

Option 2: U.S. Supervisory Engineer, Local Technical Personnel

Equipment specification, procurement 5 days @ $250	$ 1,250
Field studies 5 days @ $250	1,250
Supervision 15 days @ $250	3,750
Per diem 25 days @ $80	2,000
Travel and Misc.	2,500
Local help technical:	
e.g. 18 sites x 3 days x $50	2,700
Local help - labor	
e.g. 18 sites x 5 person days x $20	2,160
	$15,610

Note: Assumes procurement undertaken by USAID or Ministry of Health, based on specifications provided by consulting engineer.

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PART I

APPLICATIONS ASPECTS

OF A

TWO WAY RADIO COMMUNICATION SYSTEM

FOR

INTEGRATED RURAL HEALTH SERVICES

IN

ECUADOR

Heather E. Hudson, Ph.D.

March, 1982

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1. Background

1.1 Request for Assistance

USAID Ecuador is undertaking a project in integrated rural health delivery to assist the government of Ecuador in improving the health of the rural population, through delivering low cost health services to the rural poor. This objective will be achieved by strengthening Ecuador's health service delivery institutions and by introducing low cost technologies into the delivery system. The project will finance improvements in institutional capacities as well as field demonstrations in low cost primary health care, water supply, sanitation, and nutrition interventions in three Integrated Rural Development Areas.

The project will be implemented by the Integrated Rural Development Secretariat of Ecuador, in conjunction with other rural development activities including:

- -- construction of feeder roads
- -- agricultural extension
- -- basic education
- -- community development
- -- agricultural production, etc.

The AID rural health project will include a pilot project in the use of two-way radio communication to support the administration and delivery of rural health services in two of the target areas.

USAID Ecuador requested assistance from AID ST/ED in the design of the radio system. Under a contract to provide technical assistance in communications planning to AID ST/ED, the Academy for Educational Development provided the assistance of Dr. Heather Hudson, Visiting Associate Professor in the College of Communication at the University of Texas, and Mr. George Gehr,

telecommunications engineer. Dr. Hudson has had experience in the planning and evaluation of two-way radio systems to support rural health services in Guyana, Pakistan, Lesotho, the Sudan, and Alaska. Mr. Gehr has also planned and installed telecommunications systems in several Latin American countries.

Dr. Hudson and Mr. Gehr undertook a mission to Ecuador in March 1982 to gather the information required for the planning of the system.*/ They met with officials in the USAID mission in Quito, and GOE officials in the Ministries of Health, Telecommunications and Agriculture, and the Secretariat of Integrated Rural Development. They also visited health facilities to be included in the project in the Quimiag-Penipe and Jipijapa integrated rural development areas. (See list of people contacted, attached)

1.2 The Use of Telecommunications in the Training and Support of Primary Health Care Workers

The growing emphasis on the needs of the rural poor in the developing world has focussed attention on creating innovative means of extending health care to rural areas. However, it is generally difficult and very expensive to extend physician-based health care into rural areas. Not only are there shortages of physicians available and willing to serve in such areas, but the use of physicians in such contexts is often a poor allocation of resources. Rural areas also generally lack the supporting medical infrastructure which physicians reply on--laboratories, diagnostic equipment, and hospitals--and the provision of these facilities would be prohibitively expensive.

As a result of these constraints and of the great need to extend health

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* Dr. Hudson was in Ecuador from March 10 to March 20; Mr. Gehr was in country from March 10 to March 27.

services to rural developing regions, a cadre of health care providers or "primary health care workers" has been developed to provide basic curative and preventive care for rural populations. These workers range from "barefoot doctors" in China to "medex" in Guyana, "community health workers" in the Sudan, "health aides" in Alaska, and "auxiliares" and "promotores" in Ecuador.

Despite their varied training and geographical and cultural setting, these health workers have much in common. They are expected to provide basic care in their communities under very difficult conditions. Drugs and supplies may take weeks or months to arrive, patient evacuations may only be possible if a vehicle happens to be available, and help may be hours or days away. Given these difficulties, two-way communications can serve many functions to provide support to isolated health workers. In many parts of the world, health workers use simple two-way radios (operated something like a taxi radio) to stay in touch with physicians at regional hospitals. In some cases the radios are used only for medical communications; in others they are shared with other government agencies. If telephone service is available, it may be used for health communications. In Alaska, health aides use a "satellite radio," a special audio-conferencing network linking health aides to regional hospitals by satellite.

These various technologies provide several functions:

- Consultation: In Alaska, health aides are in regular contact with a regional physician through a daily scheduled "doctor call." They receive assistance or confirmation in diagnosis and patient management, and may request evacuation of patients who cannot be treated adequately in the village. In other systems, such as Medex in Guyana, health workers are expected to operate

autonomously, and use the radios only for consultation for very unusual or difficult cases.

- Administration: Telecommunications can enable more efficient administration of rural health care services, as radios may be used to order supplies, arrange patient transportation, coordinate logistics, follow-up on orders, etc. In an emergency, a health worker can alert headquarters of an urgent need for antibiotics, vaccines, etc. Routinely, health workers may save weeks or even months by placing orders by radio and following up on missing shipments.

- Arranging Transportation: Telecommunications can be used to provide emergency evacuations and to coordinate visits by nurses and physicians to the field. Flying doctor services (e.g., in Kenya, Tanzania, Lesotho, and Australia) generally have the frequencies of the terrestrial radio network in their aircraft so that planes can be directed in emergencies. Some systems put radios in ambulances and field vehicles.

- Supervision: Once a primary health care worker is trained and sent out to the field (or back to the home community) he or she usually functions virtually autonomously, with only infrequent visits by supervisors or special refresher training sessions. Two-way radios can be used to provide a form of remote supervision by giving guidance and feedback to health workers in the field.

- Referral and patient follow-up: A radio system can be used to refer the patient to the next level in the health care system for diagnosis and/or treatment. Although consultation by radio may enable some patients to be treated in their home communities rather than be referred, in other cases it will still be necessary to refer the patient to a more senior level (e.g. from health post to subcenter, or subcenter to hospital). In this case, the provider can discuss with the supervisor the appropriate action to be taken, and can alert the supervisor as to when to expect the patient -- or to arrange for transportation if this is possible. The radio system can also be used to follow-up on patients that have been transferred. This is useful not only for the local provider who can then be kept informed of the management and status of the patient, but also for relatives in the home community who can be informed about the condition of the patient. For example, in Guyana, before the installation of the radio system, most remote medex did little or no patient follow-up because of the time needed for transportation to the hospital. Now a majority of the medex with radios do routine follow-up on transferred patients using the radio network.

- Morale: Finally, but not unimportantly, a communication unit can boost the morale of a health worker in a remote area. In Lesotho, public health nurses were adamant that if the government wanted to extend health services into

the remote mountain areas, it was mandatory that communication facilities be supplied for clinics there. A health aide in Alaska emphasized: "I use the satellite radio every, every, every day."

- Continuing Education: Some telecommunications systems can be used for continuing education. In Alaska, health aides learn by "listening in" to the daily doctor call with other aides on the audio conferencing system. In Guyana, weekly "grand rounds" by radio are used to present cases to the medex and to quiz them on their knowledge.

There is a variety of evidence from other developing countries that radio can effectively be utilized as a component for both continuing education for health practitioners and for community health education. Communication systems with an interactive component have been used for continuing education in a variety of settings.

In the AID-sponsored Medex Project in Guyana, a two-way high frequency radio system used primarily for administration and management of para-professional medex workers is also used regularly for continuing education. Once a week, a "grand round" is held with the physician in Georgetown, the capital, quizzing the medex on steps in diagnosis and treatment of various medical problems. The medex must present cases which they have encountered. In Alaska, a satellite-based communication system, primarily designed for consultation between village health aides and doctors in regional hospitals, was also found to have educational benefits. Due to the conference-call nature of the channel (all locations in the region shared the same frequency), health aides were able to listen to advice from the doctor to their colleagues,

and learned from these exchanges. Special courses for nurses and other field staff were offered using the system. In the South Pacific, WHO used a similar audio conference satellite network operated by the University of the South Pacific for regional seminars and follow-up training workshops for its staff and for health providers throughout the region.

2. Requirements for Two-Way Communications for Integrated Rural Health Services

2.1 The Rural Health Care Delivery System

The delivery of rural health services within each province is organized in several levels of function and responsibility. For effective management of the system, it is important to have communication between these various levels, which include

Jefatura provincial:	-- provincial chief with overall responsibility for health services
Jefatura de area de salud:	-- responsible for health services in a specified area
Centro de salud:	-- regional health center
Hospital (in canton capital):	-- regional hospital (may be colocated with health center) 15 to 25 beds: provides emergency, pediatric, OBGYN, and outpatient care.

Subcentro de salud (in parish subdivision, population over 1500):	— staffed by physician, nurse and sanitary inspector — (plans call for additional staff including dentist and dental nurse) — one or two beds; primarily outpatient care — responsible for health care in a town and its surrounding area, and for supervision of rural staff
Puesto de salud (centers with population under 1500):	— staffed by nurse trained in rural primary health care
Promotores (in villages):	— community health promoters with basic training in first aid and treatment of minor problems, and in preventive techniques including sanitation and nutrition. Primarily active in community health education.

It should be noted that Ecuador has more physicians in rural areas than many developing countries because all graduating M.D.'s are required to spend a year in rural practice.

2.2. Communications Requirements

The attached chart (Figure 1) shows the various levels and the requirements for communication between them. Generally, there is a need for supervisory communication primarily between each level and the one below it,

and for consultation, referral, and administrative support between each level and the one above it. However, the area supervisor should also be able to communicate with all providers in the system if necessary. Also, for educational applications, it may be necessary for the hospital or health center to orginate programs that can be heard by all sites.

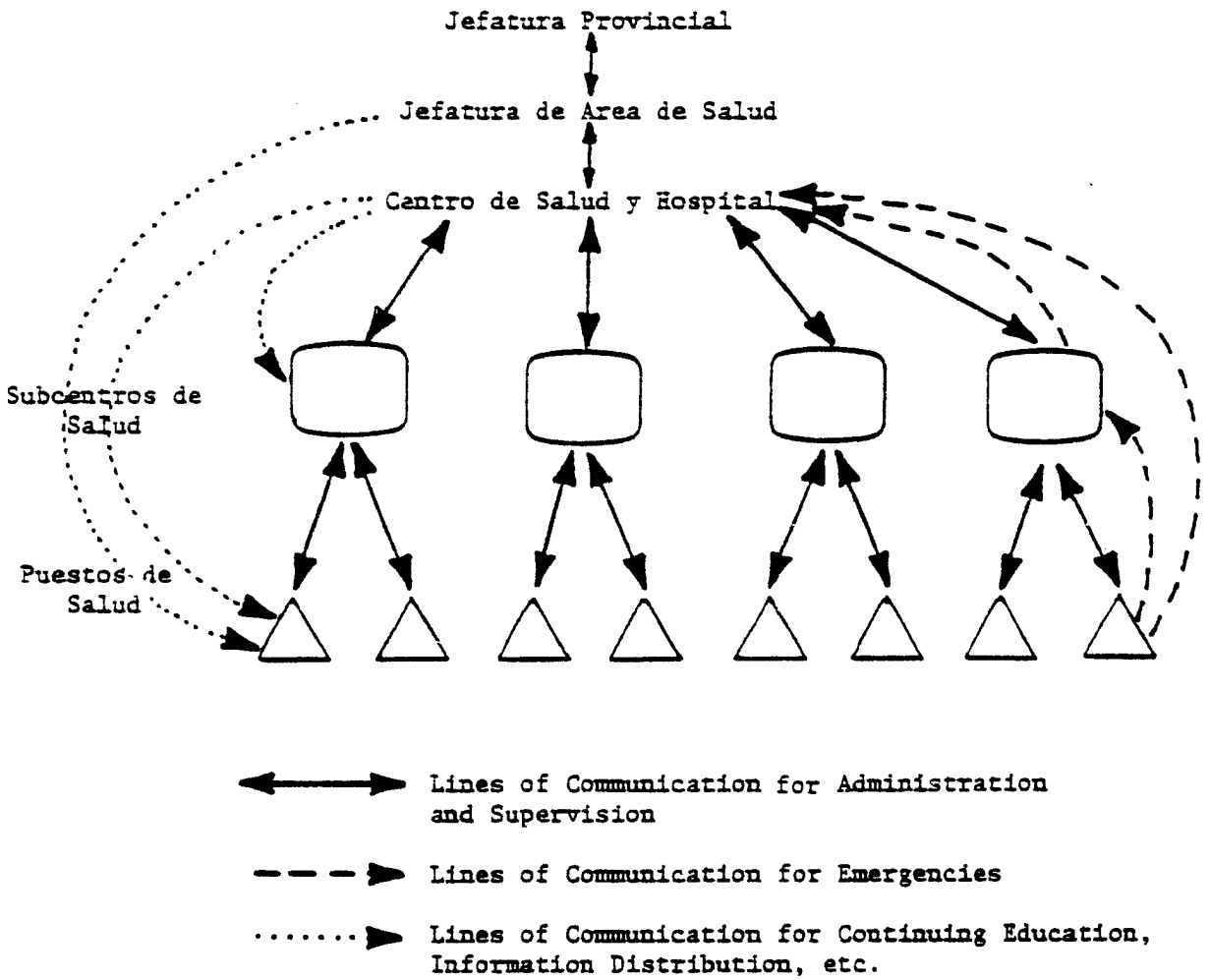
Although for normal consultation and referral, the chain of communication is likely to be with the next highest level (health posts to subcenters, and subcenters to hospitals), it will be important for all sites to be able to contact the hospital because it is the only location in the system with 24 hour per day service. All other units function basically 8 hours per day on weekdays only.

Also, for educational applications, all sites should be able to tune to the same frequency for grand rounds, tutorials, refresher sessions, etc. This "conference" feature is a special advantage of two-way radio.

It should be noted that in some cases, more than one function is located in the same town (e.g. hospital and provincial chief in Riobamba; hospital, health center, and area chief in Jipijapa). In this case there is a need for a radio only in one location, with links via phone patch to the other offices.

FIGURE 1

ORGANIZATION OF RURAL HEALTH CARE SYSTEM



2.3 Potential Functions of Two-way Communication for Rural Health Services in Ecuador

i. Emergency Assistance: Enables the medical worker (or a community resident if necessary) to request emergency assistance, including advice on treatment, request for evaluation, or notification that an emergency case is on the way.

ii. Consultation: Regular contact with a doctor for advice in diagnosis and treatment of patients, and screening of serious cases.

iii. Supervision: Supervision of field staff on a regular basis by the physician or other supervisor at a regional center.

iv. Administration and Logistics: Regular contact between regional and field sites for ordering supplies, arrangements of provider visits and patient transfers.

v. Referral and Follow-up: The radio can be used to notify a rural physician or specialist that a patient is being referred, and can enable the rural provider to follow-up on patients referred to another location.

vi. Morale: Knowing that a doctor is "on call" and that the doctor can back up a health worker's advice to a patient can boost morale. Keeping in touch with colleagues in other locations can reduce the sense of isolation, especially when a health worker is posted to an unfamiliar area. And information about patients away for treatment conveyed to relatives can allay their fears.

vii. Education: Informal continuing education of health workers through interaction with a physician, and with each other; conferences or seminars for health workers; follow-up to refresher courses or correspondence material.

3. Criteria for Selection of Sites

The USAID project paper has proposed that two IRD areas be selected for pilot projects using two-way radio, with the third serving as a control area. In consultation with USAID in Quito, the Quimiag/Penipe and Jipijapa IRD areas were selected. The Salcedo area will serve as a control.

If possible, it would be best to equip all locations in the health care system in these areas with two-way radios. However, budget limitations indicate that priorities may have to be set for service within each area. Criteria which should be used to select sites include:

3.1 Level of Management:

The chief of the area and of the province should be included in the system, as should the regional hospital. (It may not be necessary to have radios in each of these locations, as phone patches can be used to connect them with a radio, if several sites are located in one town.) Subcenters and health posts should be linked into the system.

3.2 Degree of Isolation:

If there are insufficient funds to link all sites at these levels, then isolation should be a major factor. Sites with poor road access and/or that are inaccessible during the rainy season should receive priority. (It was found in Guyana that the most isolated posts were heavier users of the system than those along the coast with access to roads and telephones). Sites with no telecommunications service (i.e. public telephone and/or telegraph) should receive priority over sites with some telecommunications facilities.

3.3 Motivation:

Interest in being able to communicate is likely to be a key factor in successful utilization of the system. Field staff who have a keen interest in their work and would like to be able to have more contact with

other medical staff in the area and with the regional administration are likely to be the best candidates for access to radios.

3.4 Existence of Other Rural Development Activities:

If the number of radios is limited, the existence of other rural development staff or field activities at a site should be considered in site selection. This criterion would ensure that there is maximum possibility for utilization of the system for integrated rural development goals.

3.5 Promotores:

It appears from experience in other countries that the community health workers or promotores as they are known in Ecuador, may not derive as much benefit from the communications link as other providers because of their limited functions and itinerant activities. However, it may be useful to install radios in a few locations for use by promotores, especially those who are isolated for extended periods during the rainy season, or have no means of getting messages or information from the health posts. Isolation and motivation should therefore be key factors in identifying participants.

3.6 Suggested Sites:

Several suggestions were made about priorities for two-way radio sites in the Quimiag-Penipe and Jipijapa regions, based primarily on degree of isolation and need for supervision. The following lists were suggested by field staff in each region. Final site selection should be carried out in consultation with the Ministry of Health in Quito, the area chiefs in the field, the Secretariat of Integrated Rural Development, and USAID/Quito.

Sites Identified for Two-Way Radio Pilot Project in Quimiag - Penipe

Centro de Salud:	Riobamba
Subcentros de Salud:	Quimiag (administrative center)
	Penipe
	Matus
Puesto de Salud:	Palictahua
	Quilluvacu
	El Guso (Penipe)
	Nahuzo
	Candelaria
	Chañag
	Tumba
	El Guso (Quimiag)
	Llugud

Sites Identified for Two-Way Radio Pilot Project: Jipijapa Area

Centro de Salud hospital	Jipijapa
Subcentros de Salud:	Puerto Cayo
	Manchalilla
	Puerto Lopez
	Guale
	America
	El Anegado
	Pedro Pablo Gomez
	5 de Julio
Puestos de Salud:	Julcuy
	Agua Blanca

4. Training Requirements

Rural health staff and other rural development workers who will be expected to use the radio network will require training in the operation and basic care of the radios.

One aspect of this training is primarily technical -- i.e. how to turn on the radio and select the appropriate channel, adjust volume and other controls, check the power supply system regularly (e.g. test the battery and dust off solar panels), and simple trouble-shooting (check battery, antenna leads, microphone wires etc.)

A second aspect of the training is procedural. This includes radio "etiquette" and terminology for contacting other stations, use of common radio terminology, estabishing and maintaining regular schedules for contacting various levels of the health delivery system, how to keep radio logs, etc.

The third aspect involves applications of the radio to support rural health care activities. This part of the training must show health staff how the radio is to be integrated into their other functions of supervision, treatment, and education. It should demonstrate use of the radio for these various activities and suggest applications that support the major functions of the various health care workers. Much of this training should be "hands on", i.e. actually using the radio. Although each user can be trained in the technical aspects of radio use by the crew which installs the radio on location, it is preferable to incorporate all three aspects of training in a seminar or workshop which brings the users together. They can be divided in groups so that each gets a chance to work with the equipment and to make radio calls either to a set already installed in the field or to a "dummy unit" set up for training. Each level of providers should also be instructed in how to use the system for their daily activities. Finally, each user should receive

a basic manual on radio use and wall charts (which could be made during the seminar) which give basic steps for using the radio, list all the sites in the network, list the phonetic alphabet and any other important terminology, etc.

The training workshop (which need only last one or two days) should be directed by the technical staff in charge of installing and/or maintaining the radios and by a resource person experienced in the use of two-way radio to support rural health services. These trainers could work with regional health staff to prepare the manuals and the curriculum for the training workshop.

5. Evaluation

The two way radio projects should be evaluated in terms of:

- the technical performance of the system
- utilization of the system
- benefits of system utilization for rural health and other development goals.

5.1 Technical Performance

It will be important to monitor the technical performance of the system to determine how well the equipment functions in the field, and how reliable the quality of the signal is from the various sites. Logs can be used as a primary source of data, accompanied by maintenance records and interviews with users. These sources will provide information on the performance of the various components of the system including radios, power supply, and repeaters under a variety of field conditions.

5.2 Utilization

The evaluation should also provide data on the purposes and frequency of system use, by the various levels of health providers and other

development staff. Among the purposes of utilization are likely to be:

- administration and logistics
- consultation
- referral and follow-up
- education, etc.

As noted above, logs of system use can provide these data. Each site can be provided with log sheets where they record information about each radio call including:

- date and time
- destination of call
- purpose of call
- brief summary of message
- quality of the signal (usually rated on a scale of 1 to 5).

Simple codes can be developed for these categories, so that very little effort and time is required to record the information. Log sheets can be forwarded at regular intervals (e.g. monthly) to the central administration, and can be analyzed by the evaluators. The logs can also be used to record any problems with the equipment, important messages to be relayed to others in the community, notes on absences from post, etc. A master log at the base station should also be kept of all messages sent and received. This also acts as a means of recording information and orders that are to be passed on to others, and noting that the message has been delivered. (Simple logs have been used for similar projects in Guyana, Kenya, and among native communities in northern Canada with very reliable results.) In some countries the government requires logs to be kept as part of the terms of the license.

5.3 Benefits of the System

It will be important to relate the applications of the system to the goals of the rural health program. For example, to what extent does radio communication contribute to improving the management of the integrated rural health delivery system? Has the radio network had any impact on reducing the amount of time required to obtain drugs and supplies, to obtain a doctor's advice, to coordinate health education activities? Are there other factors that have limited the benefits of the radio network such as lack of sufficient inventory of supplies, lack of vehicles, or insufficient time or personnel to develop educational applications? What changes could be made to improve the operation of the system, and/or its effectiveness?

Information on these topics is likely to be gained from analysis of the logs followed by interviews with users to review with them the applications of the system and any problems they have encountered, and to gain their assessment of utility of the system in their work and for the goals of the rural health project.

The evaluation should not be seen solely as summative (i.e. drawing final conclusions about the radio project as a whole) but primarily as a formative evaluation that will provide and can provide guidance to determine whether and how to implement similar radio systems in other development areas.

5.4 Potential Evaluators

There are several sources of expertise that could be used to carry out the evaluation. The University of Valle in Cali, Colombia, will be involved in the evaluation of the primary health care project. It is possible that with some assistance in planning of the evaluation of the communication component, they could take charge of the field evaluation. Another organization that could carry out the field evaluation with .stance in evaluation

design is CIESPAL, El Centro Internacional de Estudios Superiores de Communicacion para America Latina, which is based in Quito. Dr. Eduardo Contreras, an expert in communication research at CIESPAL, stated that CIESPAL could recommend several researchers and could coordinate field research, with appropriate guidance on the factors to be evaluated.

Such guidance for CIESPAL and/or the University of Valle could come from several sources of expertise in the United States. The Academy for Educational Development has carried out field research on several similar projects for AID. The University of Texas has a program in communication research with several faculty members who have experience in evaluation of communication projects. They include Dr. Heather Hudson, with extensive experience in the planning and evaluation of two-way radio and other telecommunications projects to support primary health care, and Dr. Emile McAnany with experience in evaluation of a wide variety of rural communication projects in Latin America. The College of Communication has close ties with the Institute of Latin America Studies at the University of Texas, which also has faculty and students experienced in evaluation design and field research in Latin America. Other universities, including Stanford and Florida State, have related experience in communication research. It is recommended that U.S. evaluators be contracted to develop the research design and evaluation instruments, including logs and questionnaires, in collaboration with a Latin American institution that would take responsibility for collection of data in the field.

6. Issues

6.1 Integrating the Radio Communication System into the Management System

Based on experience in other rural health applications of two-way radio, it is likely that one of the main functions of the system will be for administration and supervision -- i.e. regular supervision of field staff, coordinating logistics of field visits, organizing meetings and courses, ordering supplies, etc. However, to be most effective, the radio will have to be seen as a tool of the overall management system. If senior staff do not feel that supervision is one of their central duties, or if field staff expect to operate autonomously, the communication system is likely to be underutilized. Thus, emphasis on integrated management should be included in radio training, and the radio system should be presented as a tool to meet project goals.

6.2 Applications for Other Rural Development Functions

In many locations, the two-way radio system will be the only means of communication with other localities in the area. It is likely to be the most effective means of government communication, even if a telegraph office or public phone is located somewhere in the community. To derive maximum benefit from this system, it should be seen as a tool for administration of the integrated rural development program, rather than solely a tool for health communication. Thus, there should be a link to the area chief so that he can monitor rural development activities in the field. In some cases, health subcenters are colocated with other development offices. There should be a general orientation for rural development field staff so that they are also able to use the radio system even if it is located in the health center.

6.3 License and Utilization Fees

The director of frequencies for IETEL, Ing. Franco Munoz, stated that there were not likely to be any major problems in obtaining frequencies for the radio networks once the appropriate documentation was supplied. However, he stated that the government charges private users for the use of radio communication systems. Although he could not provide an exact price quote without more detailed information, he estimated that the charge for a system of 12 sites with two frequencies operating 12 hours per day would be 27,840 sucres per month (or about $700 per month.) He indicated that a waiver of this fee might be possible if the Minister of Health wrote a letter to the Minister of Communications. It will be important that this issue be resolved and a waiver obtained before equipment is procured for the project.

6.4 Community Health Education

Among the major health problems in rural Ecuador are diarrhea and other digestive disorders, parasites, genito-urinary problems, and respiratory problems. The solution to these problems will require changes in attitudes and behavior as well as environmental improvements. The AID integrated rural health project emphasizes improved sanitation and nutrition. A major component of these improvements will be community health education. However, communication can also be used to reach rural residents directly. For example, radio broadcasting could be an effective tool to reach rural families with information on the importance of personal and community sanitation, nutrition, prevention and treatment of infant diarrhea, etc. Radio programs could also be used to support other components of the integrated rural development project. Radio broadcasts on existing stations could reach rural families, most of whom have transistor radios. Carefully planned

and targeted programs coupled with community health activities promoted by the health care providers and working with community organizations could effectively contribute to alleviating the underlying causes of many rural health problems.

It is recommended that a radio broadcasting component be included in the integrated rural development project, and that there be close collaboration with health education activities of the Ministry of Health and with community organizations such as the Campesino Training Institute and the Union of Campesino Cooperatives.

Training seminars in the use of radio broadcasting and other communication techniques for health education and community development should be included. The Academy for Educational Development provides such seminars under contract with AID. CIESPAL in Quito also has resources and expertise that could be used in such training seminars.

6.5 The Existing Telecommunications System and Options for a National Network

During our visits to the field, we inquired about existing telephone facilities in the sites visited. Many locations had no telephone or telegraph service. Subcenters at a few locations did have telephones, but invariably they did not work, or worked so poorly that they were rarely used. For example, in Penipe, the operator stated that the telephone had not functioned properly since the installation of the electrical distribution system three years previously, because of very noisy interference. The phone could only be used to send telegrams. In some locations there are telegraph offices for urgent messages. Thus the existing telecommunications facilities are not appropriate for health services or other rural development use.

The Minister of Health indicated interest in a national system for health communications. It is assumed that this would require interconnection of the various regional and subregional systems. It is not clear that a large investment in two-way radio technology would be the best solution in building such a network. The following options should be considered:

1. Connecting pilot regions and other IRD areas to Quito: If the pilot project proves to be successful, radios could be installed in other IRD areas with similar problems of isolation and poor communication. A national station (e.g. in the Ministry of Health and/or Rural Development Secretariat in Quito) could be added so that officials in Quito could be in touch with the IRD areas.

2. Interconnection with existing telecommunications system: The national telecommunications entity, IETEL, provides telecommunications services to major centers in Ecuador and to many smaller towns. The Ministry of Health could simply use the national system to reach the provincial and area level supervisors. If it was thought necessary to be able to communicate directly with the field staff, a phone patch into the radio systems could be used.

3. Telecommunications priorities for rural development: It has been demonstrated in many countries that an investment in rural telecommunications, in conjunction with other essential rural infrastructure such as roads, water supplies and electricity, is an essential component for rural development. The GOE has identified 17 target areas for IRD activities. Senior GOE officials who set rural development policy should inform IETEL of their priority communication requirements, so that IETEL's plans for rural expansion can include the national rural development priority areas. This may be a

longer term solution, but it will eventually lead to greater benefits from an investment in rural telecommunications for Ecuador's rural development.

Mass media are not generally appropriate for continuing education of field staff in developing countries because the target population is relatively small. However, radio broadcasting has been used in many countries as an effective component of community health education activities. In Tanzania, a campaign to improve community enviromental health and education used radio in conjunction with community listening groups as a key component of the campaign. In a project supported by AID in Tunisia, a radio program called "Dr. Hakim" used the character of a wise and respected physician to answer questions related to health and to provide advice on how to improve community health. In another AID supported project in the Philippines, radio programs in the form of skits or "soap operas" have been used to encourage mothers to improve their use of more nutritional foods when weaning their babies.

AID is also undertaking two pilot projects, in Honduras and the Gambia, to determine whether radio broadcasting in conjunction with local health care providers can increase mother's knowledge and proper use of oral rehydration techniques for infants. In general, it has been found that a combination of mass media and interpersonal communication for community health education has been more effective in changing behavior than either one alone. In health education, community health information activities should therefore be built around the community health workers, i.e. auxiliares and promotores, in Ecuador.

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PART II

TECHNICAL ASPECTS

OF A

TWO WAY RADIO COMMUNICATION SYSTEM

FOR THE

INTEGRATED RURAL HEALTH SERVICES

IN

ECUADOR

George A. Gehr, M.S., B.A., P.E.

STUDY PERIOD: 1982

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PREFACE

1. The Government of Ecuador (GOE) is firmly committed to improve its rural health care. Experience in this area of Public service has developed evidence that without a substantial means of communication between the various segments of this facility it is difficult to create and to maintain a high level of morale among the staff personnel, as well as to operate an efficient delivering service for critically needed drugs. It is also an effective way to monitor the effectiveness and the efficiency of the rural health care system.

This pilot program will unite the most isolated rural areas in radio communication of Ecuador. It will prove to the many health workers, and to the patients themselves that their government has an intense basic desire to develop and maintain the close coordination of its staff devoted to Public Health Service. It will provide a cost effective and highly efficient effort towards improving public health.

Because of the geographical barriers to any form of electronic communication that exist in Ecuador, as well as the many miles at inadequate roadway, poor, or non-existent telephone service and excessive remoteness, this initial or pilot program of radio communication should be simple to operate, highly efficient, and completely reliable upon demand, so that it can materially assist in the delivery of health care service.

For the above reasons two of the three original areas have been compressed into single pilot areas. This will demonstrate the effectiveness of radio communication service in public health care, and will establish a model and functioning network, that can be easily expanded into a more complex system which ultimately could include emergency services as well as a national central control.

1. Introduction

1.1. Subject Material

The study has been made to determine the feasibility of providing an operational and locally integrated system of 2 way radio communication between selected regional hospitals and their respective centers, Sub--Centers, Posts and the possible inclusion of a restricted quantity of mobile units and hand held portable radios for Health Promoters.

1.2. Objectives of the Study

The basic objectives of the proposed 2 way radio network is to increase the administrative efficiency of the health improvement plan; to minimize the unwieldy delays between equipment and medical supply ordering and delivery time; to provide a closer relatioship between all operating personnel and their respective supervisor; to coordinate the activities of the several levels of medical treatment currently being rendered to the General Public; and in general to enable management to better understand the multitude of medical and supervisory problems that exist within the ranks of their subordinates, and to assist in providing inmediate answers to such problems. The initial objective of the study is aimed more directly at administrative advancement and referrals than for emergency services. However, the basic plan is designed to ultimately encompass both administrative as well as emergency services, if so desired.

2. Area References

2.1. The areas originally established to be reviewed for this study consist of the following locations - of which sample field analysis have been complied and are presented herein.

2.1.1. Quimiag Penipe area

Health Center	-	Riobamba (Hospitals)
I.R.D.		Quimiag
Subcenter		Quimiag
		Penipe
		Matus
Health Posts		Palectanua
		Aquilluvaca
		El Guso, North
		Nabuzo
		Candelaria
		Chanag
		Tumba
		El Guso, South
		Llajud Bajo
		Pacupala
		Altar
		Panchinallay

2.1.2 Jipijapa Area

Health Center	Jipijapa
Subcenters	Porto Cayo
	Machalilla
	Puerto López
	Guale
	El Anegado
	Pedro Pablo Gómez
	5 de Julio
	América
Health Posts	Julcuy
	Agua Blanca
	Sangan
	El Vital
	Salango

2.2. It is to be noted that a certain amount of coordination will be required in the final selection of subordinate sites. Such coordination and the firm establishment of sites to be considered for the pilot program can be determined between the Ministry of Health and the Medical personnel in the field.

3. Pre Study Data

3.1. Prior to the proposed site visitation, a typical group of two way radio users in Ecuador were visited to solicit from them their experience in establishing their own two way radio networks.

3.2. A variety of generalized and relatively broad guidelines were obtained from these radio operating organization as follows.

3.2.1. The existing topographic maps are sufficiently inaccurate to render useless any calculated path studies.

3.2.2. To access all points being considered usually required a wide and composite range of frequencies unless compensating budgetary enhancement is available.

3.2.3. Lack of reliable power or power in its entirety is common in the rural areas.

3.2.4. The prohibitive cost of road construction to locate the most advantageous repeater sites.

3.2.5. The unreasonable cost of obtaining frequency allocations.

3.3. References

Voz de los Andes	Tom Folghum
Director of Frequencies	Francisco Muñoz
Ministry of Agriculture	Marcelo Morales

Texaco Robert Moore

4. Recommended equipment specification data for 2 way radio communication in Ecuador.

4.1. Ecuador is only partially mapped insofar as topography is concerned. The existing topographic maps do not reflect the actual physical displacement of elevations and as such are not suitable for point to point radio path determination.

As a result, path surveys, and the determination of the particular frequency spectrum for any individual radio path requires an actual field measurement to assure positive results. Even by the use of SSB HF with wave propagation entirely on a vertical plane for reflection effect transmission, an adequate reception level cannot be assured without field trials.

4.2. Because of the existing topography of the areas being considered for a particular network, a variety of frequencies may be necessary, with particular emphasis on the lower bands. Many of the rural towns are nominally located along canyon bottoms to be near their water source, and such location are surrounded by higher elevation hills, thus making any suitable

transmission path difficult to obtain, except by reflection (scatter) or possibly from Satelite (an extremely costly procedure).

However, certain locations are within a possible semi-visual distance from each other, and field test would easily establish the reliability of the path.

It is to be noted that existing reflection paths would be unadvisable for emergency operation (a possible future requirement) inasmuch as the overhead variable reflection media (the Heavyside layer) is not constant, and suitable transmission is limited to a few hours per day, usually in the early morning and late afternoon.

None of the distances between the Central Control point and its subordinate offices is excessive, which under point to point transmission power for line of sight distances would be minimal (1 to 5 watts). However because of topographic variation, power as high as 25 watts and using directional or multi-directional arrays would be required. The use of a variety of radio types tends to assist in providing a higher level of assured transmission paths, but it also places a burden on warehousing and maintenance operations.

4.3. Many of the intervening ridges are above the 12.000 ft. (4.000m) elevation, and some lie well within glacial areas. A few ridges have access roads, but normally require 4 wheel drive vehicles. Most of the existing ridge access roads do not go above the 8.000 ft. (2.700 m) elevation since there has been no reason heretofor access to the higher elevations. Those ridges that do have access roads as noted, lead to areas that may or may not be suitable for the repeater sites required for this project. If existing repeaters are located on the ridge, some have a power line to the site.

Because of the problem of land acquisition for repeater operation, it is highly desirable to utilize existing sites wherever possible, if suitable arrangements can be made with the occupant. The existing facility owners of known repeater sites indicate no problem for additional occupancy will be encountered if guarentees are provided to assure non-interference with the existing systems. The repeater site selection requires field trials to determine adequacy of coverage for our radio network as well as to assure the site occupant of the non-interference element.

4.4. During the field survey for this study a relatively high percentage of Health Posts were found to have no commercial electric power, either continuous or intermittent. All of

the Subcenters have power, some with local generators that operate only on a part time basis. All Health Centers within the network have continuous power.

Under the variety of electric power sources, and to assure the positive operation of the radio network, it is felt that battery powered equipment should be recommended at all locations. By using a battery powered radio, all temporary power outages, even for those stations with continuous commercial power would not interefere with radio operation.

This source of battery charging power would be by a standard Hi-Lo trickle charger that is adequate for those locations with only intermittent commercial power service.

For those locations without commercial power of any type, solar cells would normally be suitable for maintaining battery voltage or if fuel is no problem, a rotating generator or a bi-metallic propane fired generator is suggested.

The third alternative is the use of a stationary bicycle type foot pedal-to-generator unit. This however required a steady parade of local volunteers to ride and pump the bicycle generator to maintain the required battery voltage.

4.5. The proposed repeater unit design would be based entirely upon the characteristics of the transmitted media. Its function is to pick up a directed signal on its receive unit from the originating source, activate its component transmitter and relay the information to the intended distant point. The repeater is an important and integral part of the transmission media, and for the line of site radio paths provides the means by which the signal is made to overcome an intervening obstruction, such as a mountain ridge.

The value of a repeater is a major factor in computing the over-all cost of the radio signal path since it requires a combination of two terminal send/receive units.

4.6. The assignment of the radio frequency or frequencies for a particular network is a GOE requirement and the cost for such frequency occupancy is relatively high. The pricing structure is dependent upon hours of usage, number of stations and quantity of frequency assignments. Because of the large number of multichannel two unit systems already in use for private industry or under application, the total quantities of the required frequencies required for a complete network, including the additional frequencies needed for each repeater

unit must be known. Thus, if a 4 channel system is contemplated, (8 frequencies) plus one repeater (8 frequencies) a request for 16 frequencies would be necessary. However if a broad band frequency can be provided that is of sufficient band width to accomodate a multiplexing of 4 V.F. (voice frequency) channels or more, only four basic Wide Band frequencies would be required.

4.7. In order to maintain a semblance of telephone transmission characteristics as well as to minimize the interference factor on radio transmissions for locations not being called, it is recommended that a selective calling system be considered. This system provides a means of selecting a desired station or stations, energizing a buzzer and/or a bell at the called station with an alarm lamp to signal an incoming transmission. When answered, the selected called station provides an automatic answer back to the calling station. Individual or groups of stations can be wired to receive the incoming call signal. Several hundred calling combinations are available.

4.8. In order to minimize the degree of operator training in the use of the proposed radio network, it is suggested that duplex operation be considered as compared to simplex operation. The duplex system uses a separate frequency for EW (east-west) transmission

(To talk) and a second frequency for WE (west-east) transmission (to listen). The simplex system talks and listens on the same single frequency and requires the operator at either end to push a button on his microphone whenever he wants to talk, as well as to state "over" when his conversation is ended, which notifies the far-end operator that to respond, he must push the buttom on the microphone.

In duplex operation, the removal of the handset automatically energizes the transmitter and two-way conversation can be maintained without further effort on the part of either operator. However in duplex operation, two frequencies are required for each channel.

4.9. With future expansion of the radio network in mind, it is recommended that all two way radios be multi-channel, preferably with 4 channels, even though some might not be equipped with the channel crystal. It is also suggested that the units be solid state, and fully modular to utilize or not utilize the various accessory packages that make the equipment more or less sophisticated by the insertion or removal of circuit cards.

4.10. Under certain conditions wherein channelization of the basic carrier frequency is possible, multiplexing is recommended

for the additional V.F.(voice frequency) circuits required. The cost of the mux terminal equipment is nominally equivalent to the charges for the additional frequency allocation costs.

5. Power Requirements and Generation Equipment Analysis.

5.1. No available commercial power.

5.1.1. Solar Power Panels

A recent study of Solar Panel power generating units indicates several interesting factors:

A. Useful full rated productive life approximates 10 years after which its ph tovoltaic efficiency declines more rapidly than before.

B. Efficiency factors of the panel is rated for full sunlight impingement. Thus early morning, late afternoon, and cloud overcast hours will derate its efficiency, while during the night time hours, no voltage is generated.

C. The protective covering of the panel must be kept clean and free of dust build-up to develop its unlight hour-rated efficiency.

D. Cost of the panel is relatively high, but since no fuel is required, the operating cost during its productive life is negligible. Maintenance cost is low consisting

principally of cleaning the protective covering and an ocassional check of the panel output cabling.

E. The panels are nominally rated at 13 Watts (13.2V x 1A).

F. The Solar panels are completely noise free, and can be mounted anywhere in the open to derive full benefit of the longest hours of direct sunlight. For higher charging capacities, the panels (15" x 15") can be wired in parallel. The panel is used exclusively for trickle charging.

5.1.2. Fuel driven rotating generators. These small generators come in a wide variety of voltages and charging capacities.

A. The useful rated life is an extreme variable, dependent upon the maintenance factor. However when continually used (i.e., 5 hours/day), with clean fuel and specified maintenance routines, their expected life is about 16,000 hours.

B. The efficiency factor is normally constant during its productive life if the generator is of the brushless type.

C. The packaged engine-generator sets are usually semi-protected from dust, but a ventilated covering is recommended for further protection, both from the dust, and personal injury from the heated (air cooled) engine.

D. Cost of the engine generator is approximately 2/3 that of the solar Panel - but requires a constant supply of fuel (normally gasoline); maintenance cost is minimal - requiring weekly checks of the fuel level, monthly cleaning, frequent crank-case oil changes unless the engine is of the two cycle type, which in that case, caution must be taken to assure the proper gasoline-oil mixture for combustion.

E. The engine generator equipment is nominally rated from 15 watts to 50 watts, and has the capacity to charge beyond the trickle charge rate when so desired. They are not responsive to sunlight and can be set by timer to charge at any hour.

F. The engine-generator produces the usual internal combustion engine noise. This noise can be greatly reducred by use of the metallic dust cover and by use of a "hospital" type muffler.

5.1.3. Propane fired bi-metallic generators. These are extended, or amplified versions of the Solar panel, except their source of energy is derived from a propane fueled flame (heat) rather than the sun (light).

A. Because of the high temperature required to produce voltage, the useful life of the internal bi-metallic elements

is slightly less than the useful life of the Solar Panel, and the voltage produced is directly proportional to the temperature of the super-heated series of elements.

B. The efficiency factor, which declines at a rather constant rate during its useful life can be maintained more or less constant by an increase of flame height (temperature). This however also increases the fuel cost.

C. The bi-metallic unit must have a constant supply of combustion oxygen, and because of the heat dispersal system must also be well ventilated. In addition the factor of fire hazard must also be considered. Dust is no problem since the internal heat generated usually burns off the deposited dust particles.

D. Cost of the bi-metallic generator unit approximates that of the internal combustion rotating generator, but also requires a constant source of fuel (normally propane or butane). Maintenance cost is low, normally a check to see that the burner is clean and that all burner parts produce a similar height flame.

There are no moving parts to this type of generator.

E. The bi-metallic propane fired generator is rated similar to the solar panel - and are used exclusively for trickle charging - but produce a constant lower charge rate because of their continual 24 hour operational cycle.

F. The propane fired generator unit is completely noise free, but its location must be carefully considered to minimize fire hazard, personnel injury risk, and if located indoors, oxygen depletion (ventilation).

5.1.4. Bicycle power units

A. These foot powered units are useful when ever a constant source of human power is available. They consist of a stationary bycicle unit without wheels, and with the pedal and drive chain, connected to a standard generator. In most instances the unit is built up by specification.

A. The useful life of the foot powered generator is in excess of the 10 year life of the Solar Panel, but because of their size and shape can be physically damaged. The voltage produced is directly proportional to the foot power of the rider, but is nominally rated similar to the internal combustion engine-generator set.

B. The efficiency factor is constant at a continual RPM, but because of the human element required to develop the voltage, the constant becomes a variable element. To regulate the variable element, the generator output is metered at the handlebars in order for the rider to maintain a more or less constant generator R.P.M.

C. These bicycle units are ususally mounted indoors for weather protection, and should be solidly fixed to the floor for adequate stability. When not in use, the unit should be covered.

D. The cost of the bicycle generator is less than any other type of generator, but its main drawback is the source of external driving power "who will come to the Health Post on a daily basis to ride the unit?".

E. The generator attached to the bicycle is nominally rated at 25 Watts and has the capacity to charge beyond the trickle charge rate. Maximum generator output while pedaling at an equivalent 15 km/hr is normal.

F. The bicycle generator is completely noise free except for the complaints of the pedaler.

5.2. Power generation equipment analyses where commercial power is available.

Because of the proposed battery operated radio equipment for enhancing reliable communication service, a means must be utilized to rectify the standard Public Utility 110/120 Volts A.C. to the appropriate D.C. voltage for battery charging.

5.2.1. Battery charge- Hi-Lo rectifier.

A. These rectifiers act as a combined trickle charger as well as a high level charger when required by the condition of the battery. Their useful rated productive life is in excess of 20 years. Because they are solid-state elements, their efficiency factor is normally constant during their entire life expectancy.

B. Their efficiency depends only upon the input voltage of the incoming power line.

C. Normally the units are completely self contained except for ventilation openings. Dusting the outside case, and keeping it dry are the only requirements.

D. Cost of the hi-lo charger is normally about 1/6th the cost of a solar panel. The operating cost is directly proportional to the charging current required for maintaining the battery at its proper level. The efficiency factor of the rectifier is normally about 60%.

E. The usual rating of a small rectifier is from 15 Watts to 50 Watts (the latter rating on short term demand).

F. There is no appreciable noise from the solid state battery charger when mounted properly.

6. Installation Criteria

6.1. In the proposed area of establishing radio communication, and typical of rural area displacement, the various towns are

located at the lowest point of a canyon in order to be relatively close to their water supply. This in itself creates a difficult transmission problem unless an inordinately large number of repeaters are used, or higher power transmitters, more sensitive receivers (which, when used develop a background noise problem by reason of its excessive sensitiveness), or by very low carrier frequency transmitters or by a semi tropo-scatter system which can restrict operating hours to early morning or early evening or by a combination of all.

6.1.2. The very fact of using several frequency bands then creates a maintenance problem as well as a stocking problem by reason of the diversity of equipment.

6.1.3. Standard 4 channel fixed frequency TWR set should be specified.

6.1.4. Solid-state modular construction of each unit is required to enable the system to become as diverse in operation as experience dictates.

6.1.5. Plug-in function cards are to be specified for each T.W.R. depending upon the desired sophistication level of the unit.

6.1.6. To insure adequate area coverage the control station should have at least 50 Watts of radiated power, and all other locations should have 25 Watts of power.

6.1.7. Patch panels should be required at any location that may be required to interconnect other health locations. This could even include a Health Post, if for any reason, the Control Health Center is not able to communicate with another Health Post by reason of an intervening ridge. Thus the original Health Post would become a manual type repeater for the second Health Post.

6.1.8. Phone patch panels should become an integral part of the equipment wherever Public Service telephones are available and are of adequate quality to justify their use.

6.1.9. Selective calling. This device is another requisite that materially improves the effectiveness of a multi-unit radio network (See 4.7.).

6.2.0. If the radio network is ever extended to include emergency service it may be beneficial to eventually include a Control Station tape recorder.

6.2. Antenna Installation.

6.2.1. The radio antenna is as important to good transmission as the radio itself. There are a great many types and styles of radiators and in the final installation several types will ultimately be specified. These types includes end-fed, shunt-fed, mono-vertical, dipole vertical, folded dipole, reflective, directive, Bi-directive.

6.2.2. Each installation must be individually engineered for the antenna best suited for its location, angle of transmission and purpose. Height sometimes becomes a critical factor, and all should be clear of any overhead or nearby obstruction, with a specified coax lead in to minimize transmission loss ahead of the actual radiator itself.

6.3. Power Equipment

6.3.1. General. It is proposed that all units be considered for battery operation. With proper battery charging equipment, this type of power provides the most reliable source of radio power available. (see chapter 5).

6.3.2. Because the power source of a radio transmitter is quickly forgotten once it is in place, extra efforts should be made in its placement and wiring for adequacy, ease of maintenance and in a dust free environment. Metering if provided should be easily visible. Battery volt meters should be installed, and in the case of trickle chargers, the battery charge rate is a requisite.

7. Alternative Plans for the Pilot Network.

7.1. Alternative I: Quimiag-Penipe Area: This region consists of the Provincial Health Headquarters and Hospital in Riobamba, the Subcenter facility and IRD Headquarters at Quimiag (the latter to serve as the Radio Control);

a Sub-center at Penipe and at Matus, and 12 Health Posts throughout the area.

7.1.1. The network arrangement consits of utilizing Quimiag as the control center with a connecting radio link to Riobamba, with a secondary station at its respective hospital, and each with a 2/4 wire telephone patch panel as well as a standard 4 circuit manual link-to-link patching arrangement for channel interconnection.

7.1.2. The two Health Subcenters and the 12 Health Posts would be provided with standard 4 channel modular, 25 watt units equipped as required.

7.1.3. Twenty four hour operation would be assumed between the Hospital, and Sub-Centers. Twelve hour operation is assumed to be the initial maximum hour requirement for all Health Post.

7.1.4. Utilizing the selective calling arrangement, (see 4.7) either channel (1) or channel (2) could be used for "conference" calling between Hospital, Sub-Centers, and with the 4 circuit Patch Panel at the Control Center, and using Channel 3, all Health Posts, could be included in the conference.

7.1.5. Because of the limited service offered by the telephone Co., all Health stations would be provided with radios. (17 Stations).

7.1.6. Average radio usage at the various locations is estimated as follows:

	24 Hour Station		12 Hour Station	
Function	Operate Hour	VA	Operate Hour	VA
XMIT	2	16.0	1/2	4
RCVE	24	14.4	12	7.2
	Total per Sta.	30.4	Total per Sta.	11.2

RCVE: 6A; XMIT: 8A Per Station

7.2. Alternate 2: Jipijapa Area: This regional area consists of the Portoviejo Provincial Health Headquarters, the Health Center/Hospital at Jipijapa eight Health Centers throughout the area and 5 Health Posts at various locations. The still to be determined IRD Headquarters where Health area Chief to be located, would be the Radio Control point.

7.2.1. The network arrangement consists of utilizing Jipijapa as the Control Center with a secondary station at its hospital, and each with a 2/4 wire telephone patch panel as well as a standard 4 circuit manual link-to-link patching arrangement for channel interconnection.

7.2.2. The eight Health Sub-centers and the 5 Health Posts would be provided with standard 4 channel modular 25 Watt units as required.

7.2.3. Twenty four hour operation would be assumed at the control Center and its connecting hospital. Twelve hour operation is assumed to be the initial maximum hour requirement for all other Health Subcenters and Health Posts.

7.2.4 Utilizing the selective calling arrangement (see 4.7.) either channel (1) or channel (2) could be used for "conference" calling between Health Centers, Subcenter, and with the 4 circuit patch panel at the control Center and using channel 3, all Health Posts could be included.

7.2.5. Because of the limited service offered by the Telephone Co., all Health Stations would be provided with radios (14 stations).

7.2.6. Average radio usage at the various locations are estimated as follows. (RCV:6A; XMIT:8A)

24 Hour Station			12 Hour Station	
Function	Operate Hour	VA	Operate Hour	VA
XMIT	2	16	1/2	4
RCV	24	14.4	12	7.2.
	Total per Sta.	30.4	Total per Sta.	11.2

8. Equipment Requirements and Costs

Alternate 1 - (Quimiag) Summary for Typical UHF Duplex System

Item*	Cost in U.S. $
Riobamba Hospital	$ 875.
Quimiag Control Center	4,975.
Riobamba Health Center	4,350.
Health Sub-Centers:	
Quimiag	4,470.
Penipe	4,470.
Matus	4,470.
12 Health Posts @ $4470	53,640.
System Repeater	9,815.
Subtotal Equipment	$ 87,065.
Spares @ 15% of equipment	$ 13,060.
Air Shipment (Estimated @ 5000 lbs.)	$ 7,825.
Total Material	$107,950.
Installation Labor (Estimated local labor @ 9 man-days/site x 19 + 20 man-days/travel = 191 man-days) @ $250/day	$ 47,750.
Test Equipment Rental and tools	4,000.
System Engineering (map studies, path profiles, block diagrams, detailed system specification) 60 man-days @ $300/day	18,000.
Equipment Engineering (detailed equipment specification and procurement monitoring) 30 man-days @ $300/day	9,000.
Supervision (in-country) 80 man-days	24,000.
Per diem @ $80/day	6,400.
Travel and Misc.	1,500.
GRAND TOTAL	$218,600.

*See attached equipment breakdown by site.

Alternate 2 - (Jipijapa) Summary for Typical UHF Duplex System

Item*	Cost in U.S. $
Jipijapa Hospital	$ 4,150
Jipijapa Control Center	4,975
Health Sub-Centers 8 @ 4470	35,760
5 Health Posts @ $4470	22,350
System Repeaters 3 @ $9815	29,445
Subtotal Equipment	$ 96,680
Spares @ 15% of equipment	$ 14,502
Air Shipment (Estimated @ 5000 lbs.)	$ 7,825
Total Material	$119,007
Installation Labor (Estimated local labor @ 9 man-days/site x 18 + 20 man-days/travel = 182 man-days) @ $250/day	$ 45,500
Test Equipment Rental and tools	4,000
System Engineering (map studies, path profiles, block diagrams, detailed system specification) 60 man-days @ $300/day	18,000
Equipment Engineering (detailed equipment specification and procurement monitoring) 30 man-days @ $300/day	9,000
Supervision (in-country) 80 man-days	24,000
Per diem @ $80/day	6,400
Travel and Misc.	1,500
GRAND TOTAL	$227,407

*See attached equipment breakdown by site.

MORCOM SYSTEMS INC. Equipment Examples Used for Cost Estimates

PLANNED MATERIAL LIST	PROJECT NAME	ISSUE NO.	PART NO.	SITE NO.
	ECUADOR - HEALTH	1		RIOBAMBA

PREPARED BY & DATE:	APPROVED BY & DATE:	ANALYSIS CODE	WORK NO.	PAGE NO.____OF____	PROPOSAL/PROJECT NO.
A. LANE 3-29-82					165

CODES & SM	BRIEF NAME - NO. - MFR - MODEL NO. DESCRIPTION FOR COSTING	QUANTITY & UNIT*	UNIT COST	COST	COST SOURCE CODE**
-	TELEPHONE CABLE	1 LOT	70		EST
	HANDSET	1 EA	80		EST
ACH	TELEPHONE PATCH	1 EA	200		EST
E	SELECTIVE CALL DECODER	1 EA	225		EST
E	CONTROL UNIT, TONE REMOTE	1 EA	250		EST
-	MISCELLANEOUS HARDWARE	1 LOT	50		EST
	SUBTOTAL - HOSPITAL REMOTE			875	
GE	DUPLEX BASE STATION RADIO				
	35W, 4 CHAN., UHF, E/W				
	TONE REMOTE & LOCAL				
	CONTROL UNIT, CABINET, 1 FREQ,				
	METERING, BATTERY				
	STANDBY, 220V PWR,				
	GE DC 55 JFD 78A OR EQUIVALENT	1 EA	2200		NQ 3/82
PHELPS-DODGE	DUPLEXER - 6 MHZ SEPARATION	1 EA	525		CAT
"	SINGLE 10dBYAGI ANTENNA	1 EA	235		CAT
CABLEWAVE	COAXIAL CABLE 1/2" FOAM	100FT	120		CAT
"	COAX CONNECTORS, FOAM	1 LOT	35		CAT
ROHN	30 FT SELF SUPPORTING				
	MAST IN 10 FT SECTIONS	1 EA	250		CAT
GE	SELECTIVE CALL DECODER	1 EA	225		NQ3/81
REACH	TELEPHONE PATCH	1 EA	200		EST
"	4 CIRCUIT PATCH	1 EA	200		EST
LOC PUR	BATTERY w/CASE	1 EA	80		EST
-	WIRE & MISC. HARDWARE	1 LOT	200		EST
GE	HANDSET	1 EA	80		CAT
	SUBTOTAL HEALTHCENTER REMOTE		4350	4350	

*ITEMS THROUGH WAREHOUSE - **COST SOURCE CODES: NQ - NEW QUOTE (DATE:) OQ - OLD QUOTE (DATE:)
CAT - CATALOG (IDENTIFY) EST - ESTIMATE (INITIAL) PO - OLD PURCHASE (DATE & NUMBER)

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MORCOM SYSTEMS INC. Equipment Examples Used for Cost Estimates

PLANNED MATERIAL LIST	PROJECT NAME	ISSUE NO.	PART NO.	SITE NO.
	ECUADOR - HEALTH	1		QUIMIAG

PREPARED BY & DATE:	APPROVED BY & DATE:	ANALYSIS CODE	WORK NO.	PAGE NO.____OF___	PROPOSAL/PROJECT NO.
A. LANE 3-29-82					165

CODES & SM	BRIEF NAME - NO. - MFR - MODEL NO. DESCRIPTION FOR COSTING	QUANTITY & UNIT*	UNIT COST	COST	COST SOURCE CODE**
GE	DUPLEX BASE STATION RADIO				
	50W, 4CHAN, UHF E/W				
	LOCAL CONTROL, CABINET				
	METERING, BATTERY				
	STANDBY, 220V PWR, 4 FREQ.,				
	GE DC65EFD78A OR EQUIVALENT	1 EA	2300		NQ 3/82
P-D	DUPLEXER - 6 MHZ SEPARATION	1 EA	525		CAT
"	MULTIDIRECTIONAL				
	ANTENNA ARRAY w/PWR SPLITTER	1 EA	485		CAT
CABLEWAVE	COAXIAL CABLE 1/2" FOAM	100 FT	120		CAT
"	COAX. CONNECTORS, FOAM	1 LOT	35		CAT
ROHN	50 FT SELF SUPPORTING				
	MAST IN 10 FT SECTIONS	1 EA	425		CAT
GE	SELECTIVE CALL DECODER	1 EA	225		CAT
REACH	TELEPHONE PATCH	1 EA	200		EST
"	4 CIRCUIT PATCH	1 EA	200		EST
LOC PUR	BATTERY w/CASE	1 EA	80		EST
GE	HANDSET	1 EA	80		CAT
-	WIRE & MISC. HARDWARE	1 LOT	300		EST
	SUBTOTAL - (IRD) CONTROL CENTER			4975	

*ITEMS THROUGH WAREHOUSE - **COST SOURCE CODES: NQ - NEW QUOTE (DATE:) OQ - OLD QUOTE (DATE:)
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MORCOM SYSTEMS INC. Equipment Examples Used for Cost Estimates

PLANNED MATERIAL LIST	PROJECT NAME	ISSUE NO.	PART NO.	SITE NO. JIPIJAPA
PREPARED BY & DATE: A. LANE 3-29-82	APPROVED BY & DATE:	ANALYSIS CODE	WORK NO. / PAGE NO.____OF____	PROPOSAL/PROJECT NO. 165

CODES & BK	BRIEF NAME - NO. - MFR - MODEL NO. DESCRIPTION FOR COSTING	QUANTITY & UNIT*	UNIT COST	COST	COST SOURCE CODE**
GE	DUPLEX BASE STATION RADIO				
	35W, 4CHAN, UHF E/W				
	LOCAL CONTROL, CABINET				
	METERING, BATTERY				
	STANDBY, 220V PWR, 1 FREQ.,				
	GE DC55EFD78A OR EQUIVALENT	1 EA	2200		NQ 3/82
P-D	DUPLEXER - 6 MHZ SEPARATION	1 EA	525		CAT
"	SINGLE 10dB YAGI ANTENNA	1 EA	235		CAT
CABLEWAVE	COAXIAL CABLE 1/2" FOAM	100 FT	120		CAT
"	COAX. CONNECTORS, FOAM	1 LOT	35		CAT
ROHN	30 FT SELF SUPPORTING				
	MAST IN 10 FT SECTIONS	1 EA	250		CAT
GE	SELECTIVE CALL DECODER	1 EA	225		CAT
REACH	TELEPHONE PATCH	1 EA	200		EST
LOC PUR	BATTERY w/CASE	1 EA	80		EST
GE	HANDSET	1 EA	80		CAT
-	WIRE & MISC. HARDWARE	1 LOT	200		EST
	SUBTOTAL - HOSPITAL			4150	

*ITEMS THROUGH WAREHOUSE - **COST SOURCE CODES: NQ - NEW QUOTE (DATE:) OQ - OLD QUOTE (DATE:)
CAT - CATALOG (IDENTIFY) EST - ESTIMATE (INITIAL) PO - OLD PURCHASE (DATE & NUMBER)

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Equipment Examples Used for Cost Estimates

MORCOM SYSTEMS INC.

PLANNED MATERIAL LIST	PROJECT NAME	ISSUE NO.	PART NO.	SITE NO.
	ECUADOR - HEALTH			JIPIJAPA

PREPARED BY & DATE:	APPROVED BY & DATE:	ANALYSIS CODE	WORK NO.	PAGE NO.____ OF____	PROPOSAL/PROJECT NO.
A. LANE 3-29-82					165

CODES & EM	BRIEF NAME - NO. - MFR - MODEL NO. DESCRIPTION FOR COSTING	QUANTITY & UNIT*	UNIT COST	COST	COST SOURCE CODE**
GE	DUPLEX BASE STATION RADIO				
	50W, 4CHAN, UHF E/W				
	LOCAL CONTROL, CABINET,				
	METERING, BATTERY				
	STANDBY, 220V PWR, 4 FREQ.				
	GE DC65EFD78A OR EQUIVALENT	1 EA	2300		NQ 3/82
P-D	DUPLEXER - 6 MHZ SEPARATION	1 EA	525		CAT
"	MULTIDIRECTIONAL				
	ANTENNA ARRAY w/PWR SPLITTER	1 EA	485		CAT
CABLEWAVE	COAXIAL CABLE 1/2" FOAM	100 FT	120		CAT
"	COAX. CONNECTORS, FOAM	1 LOT	35		CAT
ROHN	50 FT SELF SUPPORTING				
	MAST IN 10 FT SECTIONS	1 EA	425		CAT
GE	SELECTIVE CALL DECODER	1 EA	225		CAT
REACH	TELEPHONE PATCH	1 EA	200		EST
"	4 CIRCUIT PATCH	1 EA	200		EST
LOC PUR	BATTERY w/CASE	1 EA	80		EST
GE	HANDSET	1 EA	80		CAT
-	WIRE &MISC. HARDWARE	1 LOT	300		EST
	SUBTOTAL - CONTROL CENTER			4975	

*ITEMS THROUGH WAREHOUSE - **COST SOURCE CODES: NQ - NEW QUOTE (DATE:) OQ - OLD QUOTE (DATE:)
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MORCOM SYSTEMS INC. Equipment Examples Used for Cost Estimates

PLANNED MATERIAL LIST	PROJECT NAME: ECUADOR HEALTH	ISSUE NO.: 1	PART NO.:	SITE NO.: SUBCENTER
PREPARED BY & DATE: A. LANE 3-29-82	APPROVED BY & DATE:	ANALYSIS CODE	WORK NO.	PAGE NO.____ OF____	PROPOSAL/PROJECT NO.: 165

CODES & SM.	BRIEF NAME - NO. - MFR - MODEL NO. DESCRIPTION FOR COSTING	QUANTITY & UNIT*	UNIT COST	COST	COST SOURCE CODE**
GE	DUPLEX BASE STA. RADIO 55W,				
	4CHAN, UHF, E/W LOCAL CONTROL				
	UNIT, 1FREQ, CABINET,				
	METERING, W/O 220V PWR.				
	GE DC55EFD 78A OR EQUIVALENT	1 EA		1620	NQ3/82
P-D	DUPLEXER 6MHZ-SEP	1 EA		525	CAT
"	SINGLE 10dBYAGI ANTENNA	1 EA		235	CAT
CABLEWAVE	COAXIAL CABLE ½" FOAM	100 FT		120	CAT
"	COAX. CONNECTORS, FOAM	1 LOT		35	CAT
ROHN	30 FT. SELF SUPPORTING MAST				
	IN 10 FT. SECTIONS	1 EA		250	CAT
	SELECTIVE CALL DECODER	1 EA		225	CAT
C PUR	BATTERY 12V, W/CASE	1 EA		80	EST
LAREX	CHARGER SOLAR, 8IW PEAK	1 EA		1200	EST
	HANDSET	1 EA		80	CAT
-	WIRE & MISC. HARDWARE	1 LOT		100	EST
	SUBTOTAL SUBCENTER STATION			4470	

*ITEMS THROUGH WAREHOUSE - **COST SOURCE CODES: NQ - NEW QUOTE (DATE:) OQ - OLD QUOTE (DATE:)
CAT - CATALOG (IDENTIFY) EST - ESTIMATE (INITIAL) PO - OLD PURCHASE (DATE & NUMBER)

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MORCOM SYSTEMS INC. Equipment Examples Used for Cost Estimates

PLANNED MATERIAL LIST	PROJECT NAME: ECUADOR HEALTH	ISSUE NO.	PART NO.	SITE NO.: HEALTH POST
PREPARED BY & DATE: A. LANE 3-39-82	APPROVED BY & DATE:	ANALYSIS CODE	WORK NO.	PROPOSAL/PROJECT NO.: 165

PAGE NO.____ OF____

CODES & BM	BRIEF NAME - NO. - MFR - MODEL NO. DESCRIPTION FOR COSTING	QUANTITY & UNIT*	UNIT COST	COST	COST SOURCE CODE**
GE	DUPLEX BASE STATION				
	RADIO 35W, 4CHAN, UHF E/W				
	LOCAL CONTROL UNIT,				
	CABINET, METERING, 1 FREQ.,				
	W/O 220V PWR				
	GE DC55EFD78A OR EQUIVALENT	1 EA	1620	1620	NQ 3/82
P-D	DUPLEXER 6MHZ - SEPARATION	1 EA	525	525	CAT
"	SINGLE 10dBYAGI ANTENNA	1 EA	235	235	CAT
CABLEWAVE	COAXIAL CABLE 1/2" FOAM	1 x 100FT	120	120	CAT
"	COAX CONNECTORS FOAM	1 LOT	35	35	CAT
ROHN	30 FT SELF SUPPORTING				
	MAST IN 10 FT SECTIONS	1 EA	250	250	CAT
GE	SELECTIVE CALL DECODER	1 EA	225	225	CAT
LOC PUR	BATTERY 12V, W/CASE	1 EA	80	80	EST
LAREX	CHARGER, SOLAR, 80W PEAK	1 EA	1200	1200	CAT
	HANDSET	1 EA	80	80	CAT
-	WIRE & MISC. HARDWARE	1 LOT	100	100	EST
	SUBTOTAL HEALTH POST STATION			4470	

*ITEMS THROUGH WAREHOUSE - ** COST SOURCE CODES: NQ - NEW QUOTE (DATE:) OQ - OLD QUOTE (DATE:)
CAT - CATALOG (IDENTIFY) EST - ESTIMATE (INITIAL) PO - OLD PURCHASE (DATE & NUMBER)

PAGE TOTAL $

MORCOM SYSTEMS INC. Equipment Examples Used for Cost Estimates

PLANNED MATERIAL LIST	PROJECT NAME: ECUADOR-HEALTH	ISSUE NO.: 1	PART NO.	SITE NO.: REPEATER
PREPARED BY & DATE: A. LANE 3/29/81	APPROVED BY & DATE:	ANALYSIS CODE	WORK NO.	PROPOSAL/PROJECT NO.: 165

PAGE NO.____ OF____

CODES & BM	BRIEF NAME - NO. - MFR - MODEL NO. DESCRIPTION FOR COSTING	QUANTITY & UNIT*	UNIT COST	COST	COST SOURCE CODE**
GE	DUPLEX BASE STATION RADIO				
	50 W, 1 CHAN., UHF,E/W				
	S.O.R., DC REMOTE CONTROL				
	CARD, CABINET, METERING,				
	1 FREQ., 4 WIRE AUDIO.,				
	W/O 220V POWER				
	GE DC 65EFD 78A OR EQUIVALENT	2 EA	2100	4200	NQ 3/82
	(NOTE: 2 RADIOS AS ABOVE - FUNCTION				
	AS 1 REPEATER)				
P-D	DUPLEXER - 6 MHZ SEP.	2 EA	525	1050	CAT
"	OMNI OR MULIDIRECTIONAL ANTENNA				
	ANTENNA ARRAY w/POWER SPLITTER	2 EA	485	970	CAT
CABLEWAVE	COAXIAL CABLE 1/2" FOAM	2 X 100FT	120	240	CAT
	COAX CONNECTORS, FOAM	2 LOT	35	70	CAT
ROHN	50 FT SELF SUPPORTING				
	MAST IN 10 FT SECTIONS	1 EA	425	425	CAT
	BATTERY 12V, w/CASE	2 EA	80	160	EST
SOLAREX	SOLAR CHARGER, 80 W PEAK	2 EA	1200	2400	EST
-	WIRE & MISC. HARDWARE	1 LOT	300	300	EST
	TOTAL REPEATER			9815	
	(NOTE: ABOVE ESTIMATE DOES NOT				
	INCLUDE BUILDING OR CIVIL WORKS				
	FOR ACCESS ROAD.)				

*ITEMS THROUGH WAREHOUSE - **COST SOURCE CODES: NQ - NEW QUOTE (DATE:) OQ - OLD QUOTE (DATE:) CAT - CATALOG (IDENTIFY) EST - ESTIMATE (INITIAL) PO - OLD PURCHASE (DATE & NUMBER)

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9. Equipment Considerations

9.1. Because of budget considerations the two Alternative plans are suggested for Administrative consideration. Their respective costs are relatively identical, and the service they will provide will be of equal benefit to their individual and respective areas.

The Jipijapa area is a little more isolated with many fewer public telephones. However, the public telephones in Quimiag and Riobamba leave much to be desired.

9.2. The proposed future emergency service is designed primarily for mobile communication and only the channel facility of the transmitter and the receiver has been provided, this same service can be provided for Promotores with hand held portable 2 Watt Units, each costing approximately $550 for the mobile unit, and $250 for the hand held unit.

9.3. Without an extensive array of repeaters (in addition to those proposed) it would not be possible to provide equipment to permit any Health Post to report to its individual supervisory Center.

In Lieu thereof; the Control Center can use its 4 circuit Patch panel to interconnect the incoming transmission to a radio channel that will reach the desired supervisory point.

In certain instance in which the Health Post can communicate only with a nearby Sub-Center, instead of directly to the Control point, a secondary 4 circuit Patch Panel can be provided for that intermediate switching function.

9.4. Equipment Type Considerations

9.4.1. Radio Equipment.- The type of two way radio equipment required is as follows:

- Modular Construction
- Fully solid state
- Single sideband (SSB), or VHF
- Frequency range 2 to 10 Mhz, or 50 to 120 Mhz.
- Power output, control Sta. 50 watts all others 25 watt
- 4 channel capacity, equipped with four crystals, frequencies to be specified in accordance with frequency allocation
- to operate on 12 VDC or 120 V. - 60 Hz AC with simple wiring option to change from one to the other
- Handset with receiver gain control
- Key operated Loud speaker
- Spare parts kits

- Frequency station selector with alarm
- Telephone patch panel where specified
- 4 circuit Patch Panel where specified
- Manual of Operation
- Manual of Maintenance

9.4.2. Antenna Equipment.- The antenna type recommended is a coaxial cable-fed, simple half-wave dipole supported 1/8 wavelength above ground. One dipole arrangement is required for each frequency of operation. It is suggested that dipoles pre-cut to the proper frequency, and pre-assembles with the necessary hardware and 100 feet of coaxial cable be ordered. Two supporting wood or steel poles and necessary guys and anchors are required per location. Poles and hardwares should be obtained locally.

9.4.3. Power Equipment.- There are several possibilities for powering radio equipment where an existing power system does not exist. All radio units will operate on 12 volts D.C. from a battery being charged by a rectifier unit from the A.C. line if such exists or by a solar cell where commercial power does not exist.

A. Solar Panel.- Photo-voltaic solar panels used in conjunction with lead-acid type storage batteries appear to be the most suitable arrangement in non-commercial power areas.

These panels have been successfully used for radio operation. The lack of fuel requirements and the lack of maintenance associated with solar cell installations make this battery charging technique suitable in sunny area locations such as in Ecuador. The life of solar panels is estimated to be in excess of 15 years.

Based on photo-voltaic cell panels available from Solar Power Corp. of Billerice, Mass., it is estimated that one 36 cell panel coupled with a 100 ampere hour lead-acid battery will permit 1 1/2 hours per day operation of a 25 watt transceiver for 20 consecutive sunless days.

All 50 watt 2 way radios are located in areas that have commercial A.C. power, and as such their 12 volt battery will be charged with a hi-lo rectifier, i.e., 2 A/IOA. powered by 110 Volts A.C.

B. Wind Generators.- like solar panels, do not require fuel. Unlike solar panels, however, they contain moving parts with their attendant maintenance requirements and lowered reliability. Cost figures indicate that wind-charger costs are 1.5 times the cost of the solar panel.

C. Gasoline-engine Driven Generators.- This is the last choice of the various power sources being considered for charging the radio battery . Although the initial capital cost of a gasoline-engine driven generator may be lower than for either solar panels or a windmill, the logistics of providing fuel, need for regular maintenance, lower reliability, and shorter life do not favor this power source, except as a standby generator.

9.4.4. Radio Equipment Costs.- A suitable 50 watt, 4 channel 2 way radio as described under Section 9.4.1. would cost in the region of 1.400 U.S., while the 25 Watt 4 channel unit is valued at approximately US$1.150.

9.4.5. Antenna Costs.- The dipole antenna, precut and assembled with all necessary hardware and 100 feet of coaxial cable would cost approximately US$200.

Two treated poles and necessary anchoring hardware are valued at US$100 each (available locally).

9.4.6. Power equipment costs.- Each Solar Module plus 1-100 ampere-hour battery, together with an ammeter to observe the charge rate of the panel will cost about US$500.

10 Maintenance Considerations

10.1. Importance of Maintenance.- The importance of proper routine maintenance of all 2 way radio installations cannot be over stressed. Although the radio network may use the most modern and up to date equipment and all its software properly designed and constructed, the performance of the network will slowly deteriorate over time unless regular, routine maintenance procedures are followed. It is necessary to program regular on-site visits at intervals not to exceed 6 months, to inspect, adjust and repaid, if required, all hardware and software parts of the system (The antenna is usually the most neglected part of radio maintenance, and is probably responsible for more problems than the radio equipment itself.)

10.2. Maintenance Considerations

10.2.1. Maintenance Functions.- There are two basic functions involved in keeping the network in good operation. One is site maintenance: this includes regular semi-annual checks of each site including testing and tuning of the radio, and checks of the antenna and power supply systems.

The second is the repair function.- i.e. servicing of radios that have broken down. Solid state electronics with modular design (e.g. with printed circuit cards) should result in high reliability and ease or repair.

However, electronics skills will be required to repair the radios.

10.2.2. Human Resource Development.- Another consideration is the extent to which local people can be trained to take charge of operating, and a great deal of the minor maintenance problems that regularly occur.

10.2.3. Institutionsl Commitment.- The commitment of the institution charged with maintenance responsibility is also an important consideration. It is assumed that the MOH commitment to its own system would be high. The priority assigned to MOH system maintenance will depend on their training workload, financial incentive, and/or the importance they assign to two-way radio operations.

10.3. Maintenance Options.- There are a number of ways to approach the maintenance aspects of the radio network, each with its respective advantages and disadvantages and varying degrees of benefit to the development of the health care considerations for the people in the area being served by the radio system.

10.3.1. Maintenance Contract with a Suitable Private Firm or Non-Government Organization

Assuming a suitable firm can be found, the advantage of this arrangement is that the responsibility for maintenance repair would be within a firm whose business is two-way radio. They would operate with an efficiency resulting from complete familiarity with the subject.
A highly probable disadvantage is that the firm might not be interested in supplying the maintenance service unless the faulty equipment is brought to their repair shops. This means that an adequate stock of replacements radio sets must be immediately available.
It is estimated that the annual cost of a maintenance and repair contract with a local radio repair organization would be approximately as follows for in-shop repair:

Per Hour		$20 + Parts
Warranty extension	20 sets	$30 Per Year + Parts

It is not unreasonable to expect that annual cost of subsequent maintenance contracts will increase as the installations ages. No maintenance shop appears to be interested in field maintenance of any kind.

10.3.2. Developing a Maintenance Capability within the MCH

The feasibility of this option hinges on finding the proper personnel, both a technical expert and suitable local technically trained personnel. So far no Government Agency has been found that is willing or possesses the equipment or the expertise to repair 2 way radios adequately. Defective units will have to be replaced on site, and the faulty unit shipped to the contract repair shop. This option calls for equipping the local Health group with the necessary equipment, vehicle and personnel to make such minor repairs as they can, and to have the time and knowledge to replace faulty units on site with spare sets.

11. Training and Evaluation

Two types of training must be considered

11.1. Training of radio users, i.e. hospital and clinic personnel, and

11.2 Training of radio network operations and maintenance personnel, to enable them to make minor repairs or adjustments as required, or if the repair operation is beyond their skill, to be able to make a complete on-site replacement.

11.3 Radio Users: Medical personnel who use the two-way radio system will need to understand the following:

- Use of the Radio.- how to transmit and receive, when to change channels, how to use the selective calling unit, and the telephone patch and the four circuit patch panel
- Radio Protocol.- procedures including call signs, schedule check-in, monitoring, phonetic alphabet, etc.
- Logs.- importance of logs, procedures for keeping logs, where to send completed logs;
- Power supply.- parts of the power supply system, how to check for proper operation, simple trouble-shooting.

A manual will be provided with simple explanations and diagrams to cover the above points. In addition, the installers will provide basic instruction on use of the radio and trouble-shooting while in the field. However, we recommend a training workshop involving at least one radio operator from each site. The workshop would cover all the above points in detail, give participants practice in using the radio properly, doing routine checks of their equipment, trouble-shooting, and describing problems and broken parts to the project persons. These skills will be important as the radio users will have to ensure that the antenna

system and power supply are checked regularly, and will have to be able to indentify broken parts (e.g. insulators, guywires) or describe serious problems to the local personnel.

Since the logs will be an important component of a later evaluation it will be important to ensure that the users understand their significance and how to complete them. The workshop should last two to three days in order to cover all points involved and to provide some operating experience.

11.4. Technical Training.- As we have discussed elsewhere in this report, system maintenance raises several major problems.

- There is no GOE Agency that is interested in maintaining this health ministry radio network.
- Local Quito electronic firms are capable of radio servicing but are not interested in field maintenance.
- Trained radio technicians tend to move to more prestigious jobs in telecommunications or to leave for much higher paying jobs in larger towns.

For in-shop maintenance we recommend that radio servicing be done by a local firm. However, there would still be a need for a Health Ministry technical manager to take responsibility for the system.

Tasks of the Communication Technical Manager, will include:

- keeping an inventory of spare sets and spare parts;
- shipping spare items to site as required
- exchanging spare radios with faulty radios from the field and sending radio out for repair, and recovering the repaired unit.

We propose that the majority of training for all options be on-site. Local personnel would work with the installer in the field to learn installation, antenna and power supply maintenance, and radio testing. The Technical manager would learn about inventory procedures from the Ministry of Health and such record keeping as necessary.

11.5. Evaluation

11.5.1. Purposes of Evaluation.- It will be important to evaluate the two-way radio project to determine to what extent it has met the communication requirements of the MOH and to determine what action will be required at the end of each 1 year study period- e.g. continued operation of the existing system, expansion of the system, integration with other networks, etc., or with a national Control Point.

Among the questions to be answered by the evaluation are:

1. How reliable is the system? What problems have there been?
2. Forwhat functions is the system used?
3. What is the opinion of the users about the value of the system?
4. What effects has the system had on health care delivery e.g. better administration, emergency assistance, substitution for transportation, etc?
5. Should the system be improved? modified? expanded?
6. How satisfactory are the institutional arrangements for operations and maintenance?
7. What is the status of rural communication planning for the country? Should the MOH system be integrated with a national system?

In addition to providing answers to these and other questions, at the end of the study period the collection of data during the project will be an important source of information for formative evaluation.

11.5.2. Evaluation Plan.- An important source of information will be simple logs kept at each site. Maintenance records will also be used. "Before and after" interviews will be conducted with users concerning their requirements, expectations ... ...

of the network, opinions about the network and its effectiveness, Key officials will also be interviewed.

A budget should be provided for each year of evaluation by specialist (s) under each alternate Plan. The greatest activity will be following Year 1 for development of instruments and interviewing, and in Year 3 for follow-up interviews and analysis of data.

12. Plans for Project Development

12.1. Extension of communication to community health workers.- One of the goals of the rural health program is to train village health workers. It has been found that communication links between health worker and clinics or hospitals can be important for supervision of these workers, and for consultation on patient problems, as well as for logistics (e.g. notification when drugs are available at clinics), and emergency assistance.

An on-going problem in any health structure will be in supervision and encouragement. The supervisory objective of each nurse-clinician may mean that some one will receive close and substantial support, and other may be left on their own.

In many Ecuadorian communities health worker are, in fact, without supervision and support. Examples have been cited of these workers not having been contacted by a supervisor for up to several years, with drug and medical supplies either never arriving, or arriving sporadically, but always late.

It is unrealistic at this point to plan a communication system linking all village health workers to clinics. However, in certain areas where they are isolated for long periods (e.g. by snow or floods), or where travel is difficult, two-way communication will be of considerable value This pilot project using 2 way radio for relatively short distance will determine the extent to which the radio communication network will be expanded in the future.

One or more pilot projects could be added to the planned system to extend communication from clinics to villages. A careful evaluation is required to determine the cost effectiveness and suitability of this application.

12.2. Satellite Project.- USAID has approved a six-year program to give developing countries an opportunity to gain experience

in using satellite technology for rural development. Small earth stations (3 meters to 4.5 meters in diameter) powered by solar cells will be used for two-way voice communication, radio reception, and possibly TV reception. Countries will have the opportunity to participate in demonstrations (under six months) or pilot projects (one to two years).

Once the two-way radio system is in place and the training components of the rural health program are developed, Ecuador may wish to explore the possibility of satellite communication to some sites. Satellites have the advantage of providing very reliable communication regardless of terrain, and therefore, would be an ideal means of reaching remote mountain clinics. In addition, the higher reliability and signal quality would allow for seminar and continuing education programs.

12.3. The beginning of a rural telecommunication System.- As noted, telecommunication can be an important part of infrastructure to support many rural development activities in addition to health - e.g. rural construction projects such as roads, dams, and housing; agricultural projects involving extension workers; rural education, etc.

In anticipation of these application it is recommended that the radio network be accessible at certain times for non-health use, and that spare channels be included to allow for increased demand.

13. Map and Chart Section

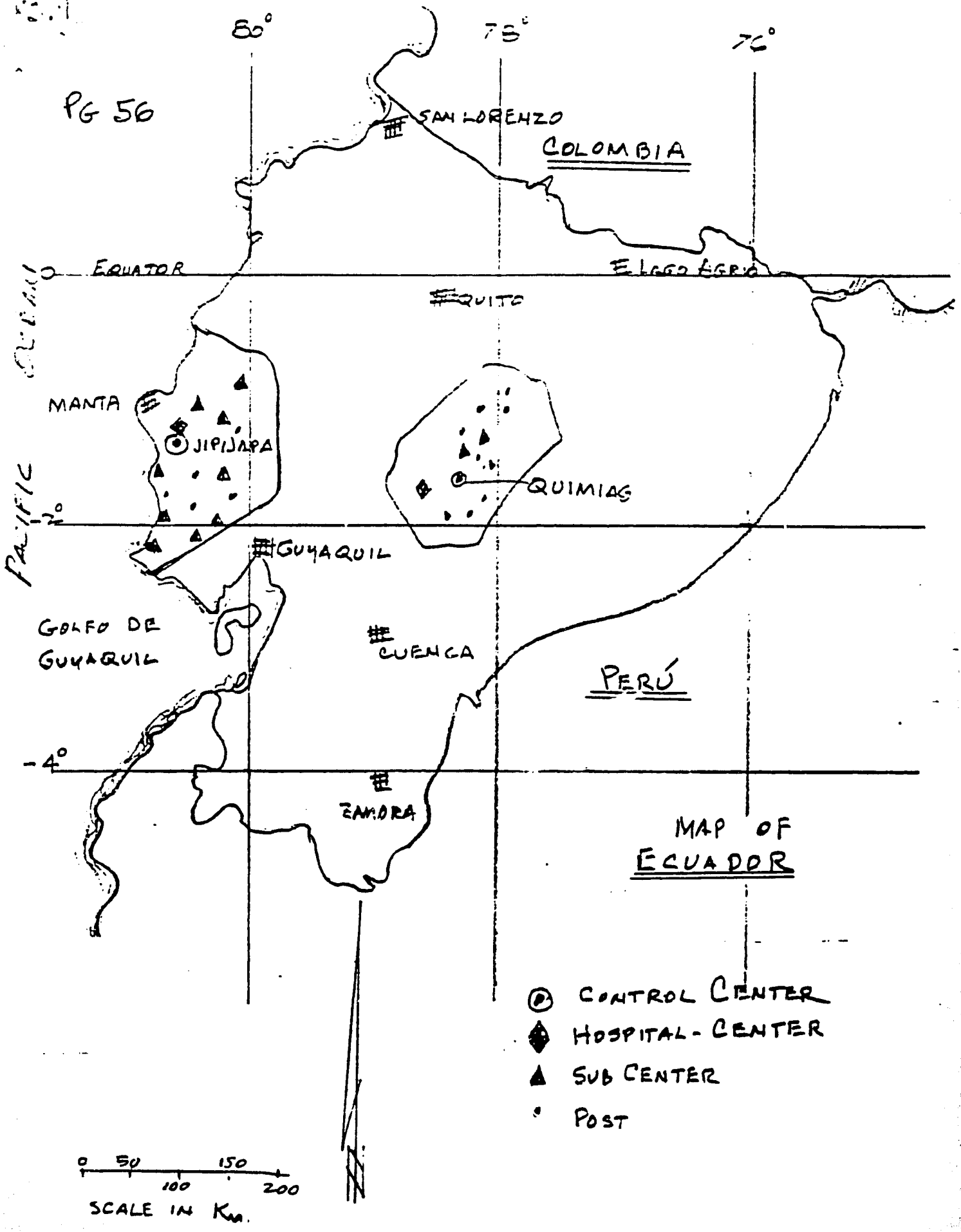
13.1. Ecuador - Map

13.2. Quimiag Block Diagram

13.3. Jipijapa Radio Network

13.4 Quimiag Path Survey

13.5 Jipijapa Path Survey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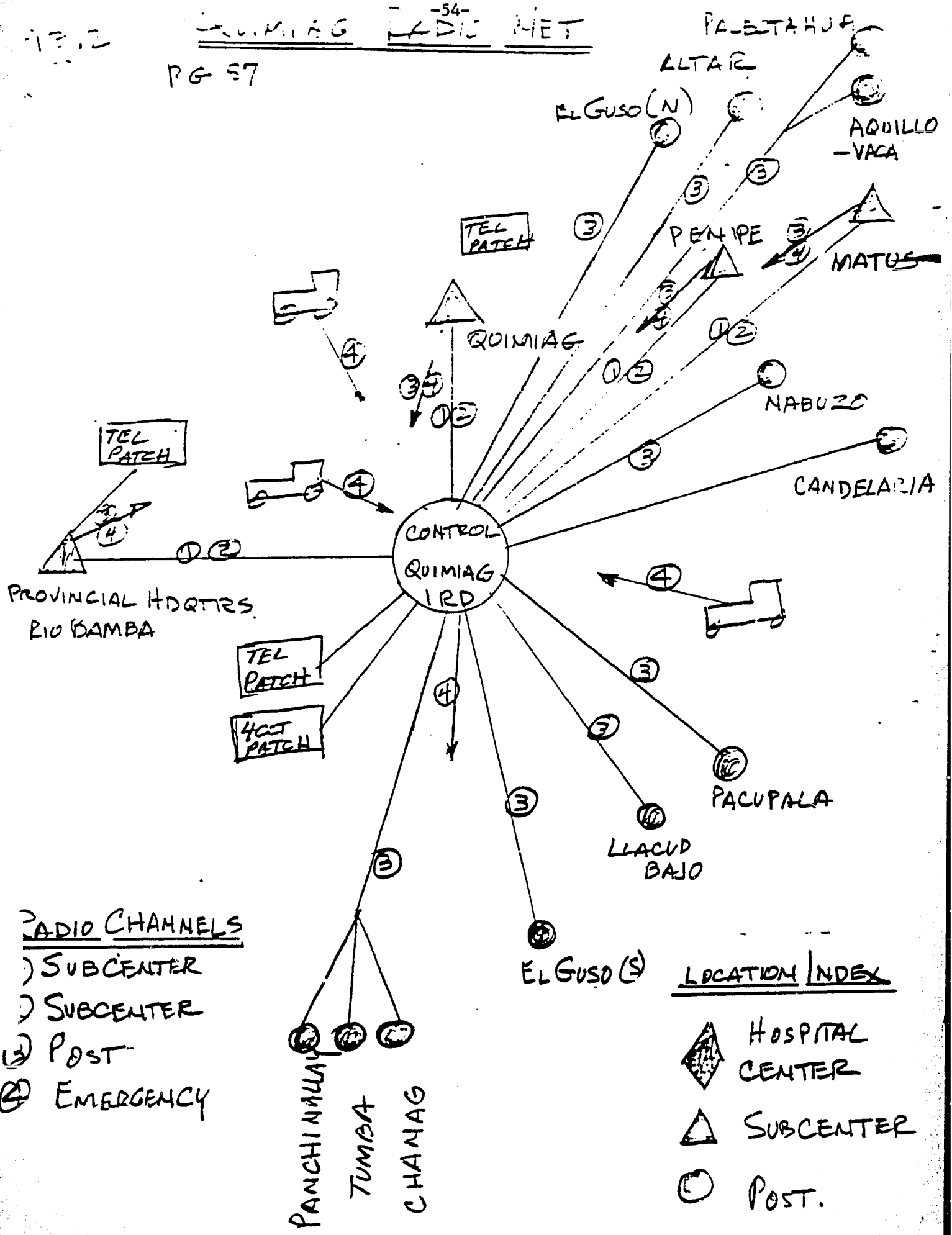
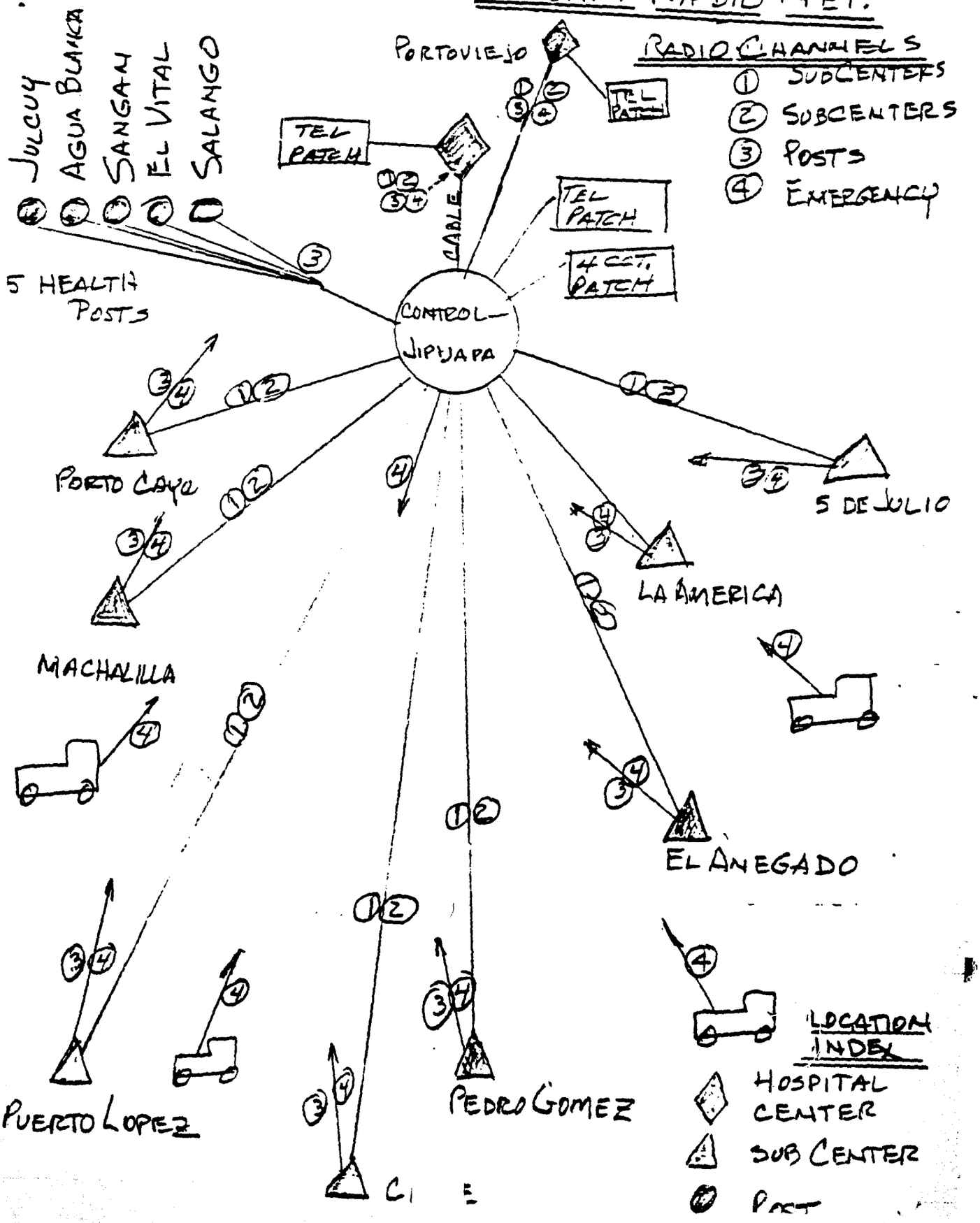
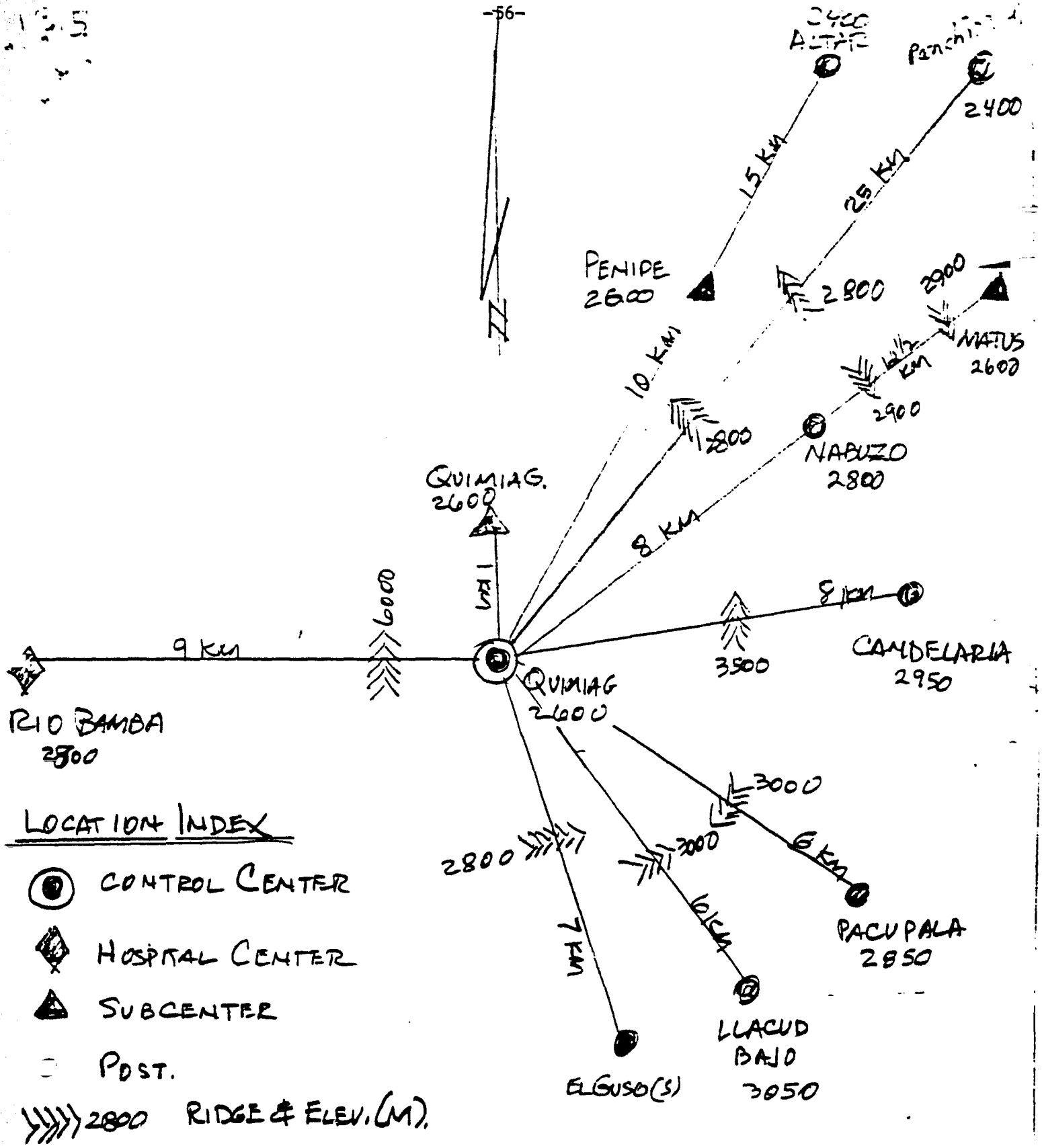
QUIMIAG RADIO NET

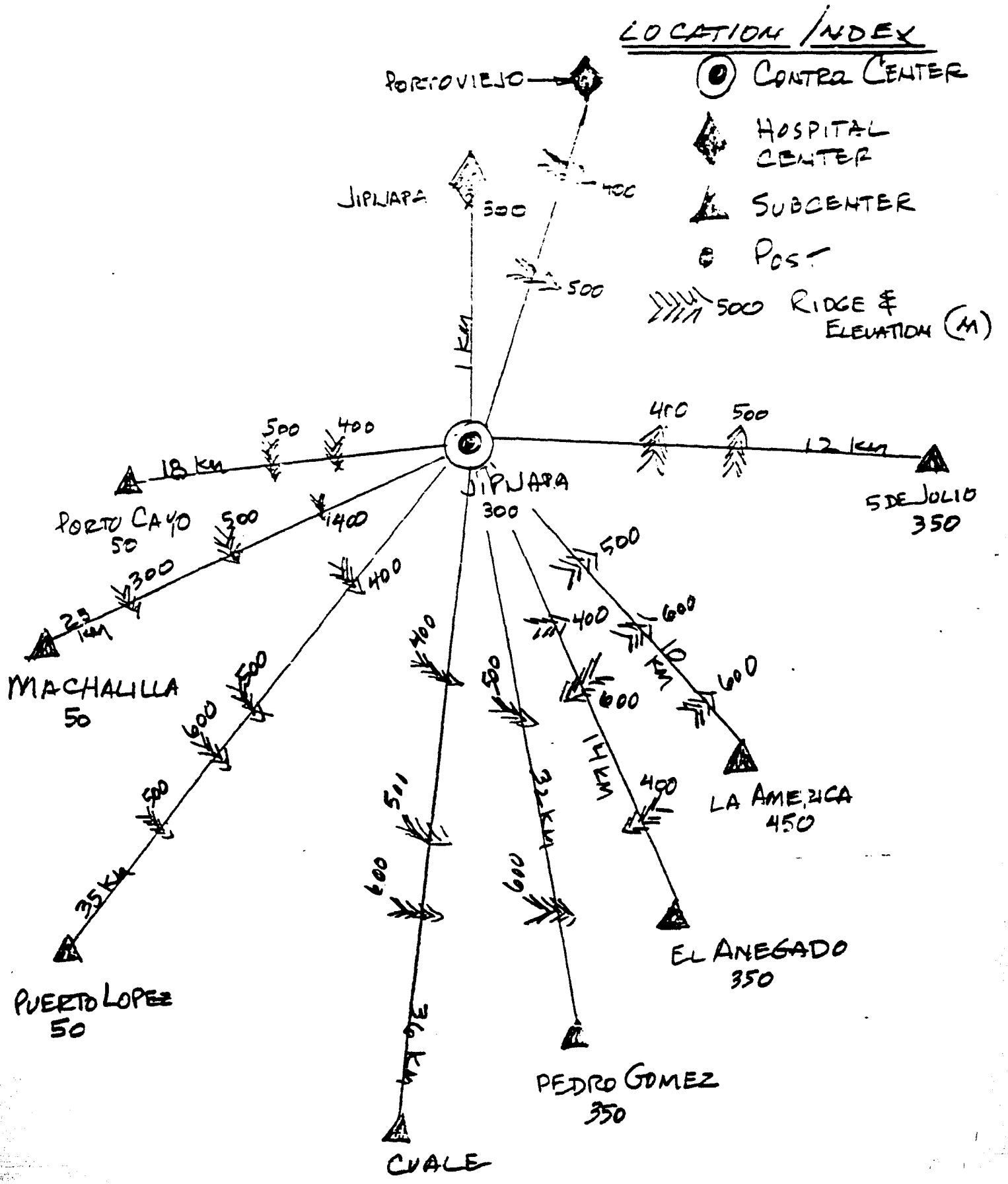
PG 57



JIPIJAPA RADIO NET.





QUIMIAG PATH SURVEY

JIPIJAPA PATH SURVEY