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REACHING ALL OF LIBERIA VIA RADIO

REPORT

by Kim Hanan Aubry
Consultant - Primary Education Project

February 11, 1989

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A REPORT PREPARED FOR THE PRIMARY EDUCATION PROJECT (PEP)

Academy for Educational Development/U.S. AID
Kim Hanan Aubry, February 11, 1989

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A Report Prepared for the Primary Education Project (PEP)

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BACKGROUND: The Liberian Ministry of Education intends to broadcast in-school educational programming to Liberia's primary schools to supplement the national (primary school) teacher training project. This ambitious project requires careful technical facilities planning in order to best use existing communications channels (broadcast) in the country. As such, the (PEP) requested that U.S. AID provide technical consultation in the form of an on-site visit by a broadcast engineer. As no new broadcasting facilities were within the scope of this project, the task at hand was to review and analyze the existing means of reaching rural Liberia.

EXISTING FACILITIES:

1) The Liberian Rural Communications Network (LRCN). The network consists of three regional production centers (with 10 kW medium wave transmitters) and a production headquarters in Monrovia. The facilities at all four locations are relatively new, the design was well engineered and the equipment appears well maintained by a full-time professional engineering staff. The network's three transmitters reach approximately 50 - 60% of the nation's land area with a useable signal according to data supplied by LRCN engineers. (See attached Map E-1)

2) The Liberian Broadcasting System (LBS). The state-run system broadcasts on medium wave, shortwave, FM and TV from Monrovia. The system is older and they are experiencing some technical problems with both their medium wave and shortwave transmission systems at the present time. I was unable to assess the technical quality at LBS during my visit.

3) The International Church of Monrovia (a multi-denominational Christian evangelical organziation) operates ELWA in Monrovia on both medium wave and short wave. ELWA's transmitters were operating at full (rated) power when I visited the station; they have backup transmission facilities and appear to be well maintained by a full-time chief engineer.

THE TECHNICAL CHALLENGE: The country's length is nearly 330 miles (maximum). Its topography varies from coastal lagoon with mangrove swamps to denseley vegetated hill country inland. Most of the rural areas are not electrified. There is no one existing broadcast channel that can reliably reach the entire nation, although it could be said that ELWA on 49 meters shortwave does appear to be well received in the morning hours within Liberia's borders. To my knowledge, no comprehensive listenership surveys have been done in Liberia. LRCN did perform some field intensity measurements in 1987, giving us an idea of their actual coverage area. Because LRCN does not ordinarily broadcast in the late morning hours, we did not know what effects atmospheric conditions would have on LRCN coverage in "fringe areas."

SYSTEM DESIGN APPROACH The intended audience for this broadcast, primary school teachers, is concerned with receiving a regular daily instructional program by radio. As such, the technical means for listening should be simple. Ordinary portable Medium Wave receivers are clearly simpler to operate (tune, adjust) than short wave receivers. Better quality medium wave (or medium wave/FM) domestic receivers are less expensive than equivalent quality multi-band shortwave sets. Medium wave reception is more predictable and reliable than short wave reception. Therefore, it would be desirable to reach as many Liberian primary schools with a useable medium wave signal as possible, relying on short wave carriage as a back-up for those areas outside the medium wave coverage zones. (E-1)

RESEARCH AND ANALYSIS The technical uncertainities that needed answers were:

1) Were the field intensity measurements done by LRCN in 1987 accurate? The measurements were done on then-new transmitter/ antenna systems. They were done during the months of May and June when the ground is wet. In January, the ground is dry.

2) Was the premise expressed (see att. 1 "Transmission Coverage of Regional Stations") "...At the 0.1 mV contour, the volume has to be turned maximum to understand the program with a lot of background noise. ...The program is audible and would be acceptable to someone interested in listening to his or her station." a correct one? This subjective statement was made using the Potomac Instruments FIM-67 Field Intensity Instrument as a raceiver in the field. Would an ordinary domestic receiver yield the same subjective result?

3) Does time of day have a great impact on the subjective quality of medium wave reception, especially in fringe reception areas?

4) Does the AED-recommended GE Superradio II perform well under Liberian conditions?

5) Can 49 meter shortwave broadcasts be reliably heard at all geographical coordinates in the late morning hours?

6) What is a cost-effective adequate quality and appropriately simple to operate short wave receiver?

7) Finally, given answers to the above, what would be the most effective and reliable existing broadcast service (or combination of services) for reaching all of Liberia's schools?

Research Methodology

A) TEST EQUIPMENT: LRCN kindly loaned us their Potomac Instruments FIM-67 field intensity meter. This is a highly accurate self-calibrated instrument used to determine objective medium wave radio-frequency field intensity (field strength) at locations of known distance from the transmitting antenna. We also employed an assemblage of domestic portable radios to make subjective evaluations on both perceived *signal* quality and on *receiver* quality and suitability.

B) FIELD TRIPS: Three field trips (over five days) were undertaken. The first was to Yekepa and Gborplay, Upper Nimba County (via Gbarnga, and Ganta.) The second was to Bo, Grand Cape Mount County; and the third was to Buchanan and Gaamodebli in Grand Bassa County. Results reported in Raw Data section.

C) FIELD REPORTS: We enlisted the assistance of contacts at various points around the country to report on subjective received signal quality during a test transmission on Thursday, January 12 at 10:00. The data from these reports is reflected in the Raw Data section.

SUMMARY OF CONCLUSIONS:

1) The LRCN field intensity measurements made in 1987 were quite accurate for Gbarnga (ELRG). Due to a lack of time, I did not verify the other measurements, however the same engineering personnel oversaw the other surveys, and they are no doubt equally reliable.

2) The data we collected using the various receivers in the field seem to confirm the premise that a received field intensity of 100 microvolts per meter (0.10 mV/m) is adequate for intelligible reception when using a <u>reasonably</u> <u>sensitive</u> <u>and</u> <u>correctly</u> <u>positioned</u> receiver.

3)Time of day does indeed have a noticeable effect on subjective signal quality: the received field intensity remains the same at all times, but background interfering noise (hiss) increases with the sun's elevation. The received (MW) signal becomes unintelligible in fringe reception areas (below 100 - 150 uV/m) after around 11:15. One can predict that the noise returns to a reasonable background level at around 14:00. Therefore, one must consider the loss in coverage experienced during this period and make program schedule decisions accordingly.

4) The GE Superradio II performed very well in the field. The MW receiver section seemed to be quite sensitive, and worked well in fringe reception areas. The sound quality is quite good, due to the conservatively designed power amplifier and 2-way loudspeaker. It will be able to play to a fairly large group of listeners (10 - 30) in an indoor space. The radio uses large D-Cell batteries which can mean longer life than other models using smaller batteries. The radio is simple to tune; the built in ferrite bar antenna is quite directional; consequently, the radio must be positioned correctly for best reception.

5) Preliminary reports indicate that ELWA on 49 meter medium wave (6.07 MHz) can be received clearly at all locations during late morning hours.

6) We tested two locally available Philips portable MW/FM/SW receivers during our field tests. The less expensive Model D-1102, though capable of tuning in ELWA-SW was found to be inadequate. With only 2 SW bands, stations are very close together on the dial. This can be a particular problem when ELBC-SW is on the air, as their frequency is nearly adjacent to ELWA's. (6.09 MHz vs. 6.07 MHz) The more expensive Model D-18 was superior in terms of tuning (it has 6 SW bands) but its loudspeaker was quite small, and it could not be played at a high volume. It uses small AA batteries which would not last particularly long. The Sony (Model 2003 or 7600) radio is by far the most sensitive and simplest to tune, but its cost is prohibitive. (At least US$200). I researched other models in the U.S. and forwarded my notes to Earl Yates at AED in Washington. The ideal portable (battery operable) shortwave radio would be a reasonably sensitive SW model with large cabinet and speaker (like the GE).

7) The most reliable and cost-effective way to reach all of Liberia's schools with a mid-morning radio broadcast would be to use a combination of the following existing services:

a) LRCN will deliver the program to populations in the three LRCN regions covering 50-60% of the country's land area.

b) ELWA-49 meter SW can reach the entire nation with a reasonably strong and reliable SW signal.

c) ELWA-711 kHz MW reaches the Monrovia geographical region, and provides a useable MW signal to coastal communities probably from Robertsport to Rivercess, possibly to coastal Sinoe. Reception reports from these coastal communities were not received in the alotted time.

FUTURE STUDY The PEP is about to embark upon a pilot project, reaching 100 primary schools. If a precise count of the number of GE receivers and SW receivers is needed, I would suggest using this time to conduct a nation-wide survey with more test broadcasts at 10:00. A more conservative approach would be to send a simple questionairre to principals of all (participating) schools, asking whether they can now pick up LRCN or ELWA-medium wave clearly. If the reply is negative, one can assume that a SW receiver is indicated. It would certainly make good sense for the PEP office to maintain some number of spare units (MW and SW) in case of loss or receiver failure.

TEACHER TRAINING As teachers receive in-class instruction at the teacher training project, they should probably recive a hands-on orientation for the radio receivers used.

GE Super II Teachers should be shown how to position the radio for clearest reception. An indelible mark should be placed on the dial at the relevant frequency to make it easier to quickly find the desired station at air time. (Since the LRCN stations are not on-air before 10:00, the radio may have been retuned to another channel, and teachers may miss the first moments of the training programs while trying to find the station.

Shortwave Radio Teachers should be shown how to select the appropriate band and then tune for ELWA (6.07 MHz). They should be instructed in adjusting the wand antenna. If it is found that SW reception (of ELWA) becomes unreliable (during other seasons); schools may be supplied with long-wire antennae. (See "Primer: Antennae")

Batteries Arrangements should be made for the distribution of batteries. Alkaline type batteries last approximately twice as long as conventional carbon-zinc (flashlight) batteries. In the U.S., they cost around twice as much. Therefore, it is a worthwhile investment as one saves on battery changes. If a supplier for alkaline type batteries can be found locally, I would recommend them. An alternative would be to invest in an inventory of rechargeable **Ni-Cad** (nickel-cadmium) batteries. When used properly, NiCad batteries can be recycled as many as 100 times before disposing of them. AC/powered battery chargers are readily available; solar powered chargers may be available, although they are expensive. I have not found an affordable one in my research.

Primary Education Project/Ministry of Education
USAID/Academy for Educational Development

Liberian Rural Communications Network Field Intensity Survey-RAW DATA

ELRG 558 kHz / 10 kW

Date	Time	Place	DX	mV/m	GEQ	CARQ	Ph1Q	Ph2Q	SnyQ	Comment
1/9	16:45	Kpein	15	1.52	5	5	5	5	5	
1/9	17:00	Ganta	25	.480	5	5	5	5	5	
1/9	17:50	Gbarda	??	.165	2.5	4	2	2.5	2	GE very drctnl.
1/9	18:10	Zortapu	??	.158	2.5	3	2	2	2	Sony very noisy
1/10	07:55	Yekepa I	80	.134	2.5	2	2	2	2	Wrong Yekepa Site
1/10	08:35	Yeleka II	84	.098	2.5	2	2	2	2	Yekepa Camp 4
1/10	09:35	Kahnplay	70	.090	2	3	<2	<2	1	Center Town
1/10	10:15	Garplay(?)	?	.185	3	2	2	2	2	(???)
1/10	11:28	Gborplay	89	.079	2	2.5	1	1.5	1	Furthest point, nearly noon.

Narrative:
We decided to make a field survey for two purposes; the first was to confirm the orginal field intensity measurements made by the LRCN engineering staff in 1987. Secondly, we wanted to make some subjective tests using a variety of receivers to determine the "useable" field strength under typical operating conditions: 1-2 hours before or after noon. LRCN kindly permitted us to borrow their Potomac Instruments MW Field Intensity Meter, and they also provided the Technical Supervisor for Gbarnga, Mr. Joseph Mulbah. We drove in the late afternoon from Gbarnga towards Yekepa, taking the same route that the previous field intensity surveyors used in 1987. We had arranged for the station to schedule extra hours of air time commencing at 16:00, ending with the resumption of the regular broadcast day at 18:00. (N.B. The station was operating at 100% of rated power which is 10 kilo watts). We discovered that ELRG was clearly receivable within the correctly predicted 500 microvolt contour (a radius of approx. 43 miles) on all of our test radios. Getting closer to the 100 microvolt point (70 mile radius), the quality of the receiver and placement of the receiver became noticeably more critical. The GE Superradio II was the best performer in terms of immunity to noise; sensitivity (the ability to pick up a weak station) and sound quality. Because the audio section of the radio is good-sized, it is possible to get acceptable listening volume from the set even in fringe areas; this was an area where the smaller Philips radios and the Sony were not competitive.

Solar Interference:

We discovered that reception in the area between 500 and 100 uV/M field intensity became noticeably worse as the sun rose in the sky, becoming marginal at around 11:20. (We were not able to evaluate the late afternoon reception quality because the station signed off at noon.) The best performing radio of the lot was the un-distinguished (factory model) automobile radio. I have found that car radios often are superior in noise immunity and sensitivity (they have to be); sometimes, they are used in fringe reception areas as fixed (table) radios. They must be provided with external loudspeakers and a 12-volt DC power supply.

In speaking with villagers at all points, people informed us that they can always receive "clear" reception of ELRG and even ELRZ, with occasional fading reception of ELRV. (We must remember that this is during the current broadcast schedule which does not include daylight hours between 08:00 and 18:00.)

PEACE CORPS INFO:

I spoke informally with Peace Corps volunteers who were at Cuttington for the National Teacher Training Workshops. They reported:

Upper Lofa County -Poor reception in Foya, none in Lorloi/Solomba. This is surprising considering Foya's proximity to Voinjama.

Lower Grand Bassa -Poor to no reception in Rivercess.

Grand Gedeh -No reception at 80 miles distance from Zwedru.

Cape Mount -No LRCN 31 miles inland from Robertsport.

All reporters believed that they could pick up ELWA on both shortwave; many thought they could get it on medium wave.

Primary Education Project/Ministry of Education
USAID/Academy for Educational Development

Liberian Rural Communications Network Field Intensity Survey-RAW DATA

Comparitive Reception Reports/Field Measurements ELWA/Shortwave (6.07MHz)

Date	Time	Place	DX	mV/m	GEQ	Othr	Ph1Q	Ph2Q	SnyQ	OtherRadio/Comment
1/12	10:00	Bo	62				4	3	4	Difficult to tune on Ph. 1 because of close spacing ELRC at 6.09 MHz.
		Kolahun (Voinjama)	141			3				Panasonic RF2200 8-band. "Clear, some fading."
		Todee (Near Kakata)	38			3				Sharp AM/FM/Cass "Clear"
		Bomi Hills				3				Sony "Multiple Band SW Radio"
		Voinjama				4				Sony 7600
1/14		Buchanan	67				4	4	4	
1/14		Gaamodebli	78				4	3	4	

Primary Education Project/Ministry of Education
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Liberian Rural Communications Network Field Intensity Survey-RAW DATA

Comparitive Reception Reports/Field Measurements ELWA/Medium Wave (711 kHz)

Date	Time	Place	DX	mV/m	GEQ	Othr	Ph1Q	Ph2Q	SnyQ	OtherRadio/Comment
1/12		Bo	62	??	?					ELWA failed to go on air MW.
1/14	10:05	Buchanan	67	5.3	4					
1/14	11:35	Gaamodebli (Kennedytown)	78	.109	2.5					

Comparitive Reception Reports/Field Measurements ELBC/Medium Wave (630 kHz)

Date	Time	Place	DX	mV/m	GEQ	Othr	Ph1Q	Ph2Q	SnyQ	OtherRadio/Comment
1/12	10:05	Bo	62	.22	3				2	
1/14	10:05	Buchanan	67	5.3	4					
1/14	11:35	Gaamodebli	78	.15	3					

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TRANSMISSION COVERAGE OF THE REGIONAL STATIONS

In accordance with our scope of work, the transmission coverage tests have been completed for the three regional stations in the cities of Gbarnga, Voinjama and Zwedru. The results obtained as tabulated on the attached sheets and drawn on the maps.

The map for the Grand Gedeh area is not accurate at all. Most of the towns listed on the maps could not be located. Therefore the plots for ELRZ is not very good. The one millivolt (1mv), zero point five millivolt (0.5 mv) and the zero point one millivolt (0.1mv) contours could not be established in all directions.

Analysis Gbarnga (ELRG)

1 mv	30 to 35 miles
0.5mv	40 to 45 miles
0.1mv	70 to 80 miles

Voinjama (ELRV)

1mv	25 to 30 miles
0.5 mv	35 to 40 miles
0.1 mv	65 to 75 miles

Zwedru (ELRZ)

1mv	16 to 20 miles
0.5 mv	24 to 26 miles
0.1mv	55 to 65 miles

The 1.0mv contour is a conservative figure for the primary coverage area. The volume on the receiver needs to be turned up only a little to get a loud and clear sound.

The 0.5 mv contour is an acceptable figure for the primary coverage area. The volume on the receiver needs to be turned up to between a quarter and half the way to get a loud sound with very very little noise.

At the 0.1mv contour, the volume has to be turned maximum to understand the program with a lot of background noise.

The program is audible and would be acceptable to someone interested in listening to his or her station.

Beyond the 0.1mv contour between the hours of 8 a.m. and 4:30 p.m. reception is very very poor. Certain areas are covered by sky waves which come in strong from about 4:30 p.m. to 8:30 p.m. and 6:00 a.m. to 8:00 a.m. Outside this time the signal is subjected to a lot of fading.

Presently our hours of transmission are during the nights and early mornings. Because of this time of transmission, we get a better coverage area. However, there are areas known as skip distances which will not receive the skywaves nor the ground waves.

The measurements were carried out from May 8, 1987 to July 1, 1987.

LRCN
BOX 2176
MONROVIA, LIBERIA

FIELD INTENSITY MEASUREMENT DATA

STATION: ELRG

FREQUENCY: 558 KHz

POWER ND:

POWER DA: 10 KW

LOCATION: Gbarnga

RADIAL AZIMUTH: Gbarnga to Bogeezay

OPERATOR

POINT	E (MV/M)	DATE	TIME	DISTANCE FROM TX.	DESCRIPTION OF POINT
		5-11-87			
Baila Bridge	[illegible].00		1022		On football field
Kpaiyata	[illegible].58		1042		Center of town
Fobbli	[illegible].00		1100	14 miles	" " "
Samita	[illegible].00		1118	20 "	End " "
Beneguelleh	3.60		1130		On football field
Gbekohn	2.10		1150	26 ✓	Near Clinic
Botota	[illegible].00		1212	30 ✓	At the junction
Gbober	1.40		1230		At end of town
Tukpata	1.20		1235		Center of town
Picafa Mission	0.94		1238		On the road
Rock Crusher	[illegible].80		1310		Center of town
St. John River	0.50		1324	40 ✓	Opposite Church
Leeyba #3 Dist.	0.36		1403		" Court House
Bassayai	[illegible].35		1413	46 ✓	Center of town
[illegible]	[illegible].09		1503	51 ✓	Near Market

LRCN
BOX 2176
MONROVIA, LIBERIA

FIELD INTENSITY MEASUREMENT DATA

STATION: ELRG

FREQUENCY: 558 KHz

POWER ND:

POWER DA: 10KW

LOCATION: Gbarnga

RADIAL AZIMUTH: Gbarnga to Yekapa

OPERATOR

POINT	I (MV/M)	DATE	TIME	DISTANCE FROM TX.	DESCRIPTION OF POINT
		5-10-87			
Palala	9.0		1055	15 miles	100 yd from Telecom Tower
Baila	3.0		1109	25 "	Near market
Kpain	1.50		1118	30 "	At the 1st junct
Yengbehi	0.82		1130	38 "	Center of town
Ganta	0.50		1140	43 "	Old gas station before Shell
Saniquillie	0.22		1225	60 "	50 yd from parking station
Yekapa	0.045		1300	84 "	Camp 4
Lamco mines	0.07		1405		Near Security Gate

LRCN
BOX 2176
MONROVIA, LIBERIA

FIELD INTENSITY MEASUREMENT DATA

STATION: ELRG

FREQUENCY: 558 KHz

POWER ND:

POWER DA: 10KW

LOCATION: Gbarnga

RADIAL AZIMUTH: Gbarnga to Salala

OPERATOR

POINT	I(MV/M)	DATE	TIME	DISTANCE FROM TX.	DESCRIPTION OF POI
		5-8-87			
Suakoko	36.00		1318	8 miles	Opposite grave
Gbartala	6.30		1305	17 ✓	Police Sub Sta
Zeanzue	3.00		1255	24 ✓	Under flower tr
Gbonkonima	1.20		1245	31.5 ✓	Entry to town
Totota	0.88		1210	39.0 ✓	Near 2nd stor
Felela	0.32		1152	47.0 ✓	Gibi road junc.
Salala	0.35			55.0 ✓	Opposite market

LRCN
BOX 2176
MONROVIA, LIBERIA

FIELD INTENSITY MEASUREMENT DATA

STATION: ELRG & ELRV

FREQUENCY: 558 KHz & 585.

POWER ND:

POWER DA: 10KW

LOCATION: Voinjama & Gbarn

RADIAL AZIMUTH: Gbarnga to Fesebu

OPERATOR

POINT	I(MV/M)	DATE	TIME	DISTANCE FROM TX.	DESCRIPTION OF POI
		5-9-87			
Wainsue	30.00		0958	8 miles	100yd from cott. tree
Belefanai	3.50		1232	20 ✓	At Nima junct
Jowa	1.20		1135	32 ✓	Near clinic
Gbalatua	1.40		1250	25 ✓	Center of tow.
St. Paul River	1.30		1305	28 ✓	Across the river
Gongloto	1.00		1318	32 ✓	Middle of town
Gollu	0.70		1335	34 ✓	Near well
Salayea	0.40		1343	48 ✓	Zolowo junctio
Gbony	0.36		1411	54 ✓	Near rock work
Zorzor	0.30		1434	61 ✓	Opposite the ga. station
Fesebu	0.30		1500	63 ✓	Store at the junction
		E	L	R	V
Fesebu	0.207		1502	✓	Store at the junction
Zorzor	0.203		1435		Opposite gas Station

LRCN
BOX 2176
MONROVIA, LIBERIA

FIELD INTENSITY MEASUREMENT DATA

STATION: ELRZ

FREQUENCY: 1250 KHz

POWER ND:

POWER DA: 10KW

LOCATION: Zwedru

RADIAL AZIMUTH: Zwedru to Tapita

OPERATOR

POINT	I (MV/M)	DATE	TIME	DISTANCE FROM TX.	DESCRIPTION OF POINT
		7-1-87			
Gboleken	2.50		0840	5.0 miles	Middle of Town
TUZON Junction	5.00		0920	12.5 ✓	Town at the Jun.
Zle Town	0.50		0950	25.8 ✓	Opposite Market Vol. mid. Hist starts
Tianbli	0.22		1015	30.8 ✓	Opposite schoo
Senewehn	0.14		1035	36.6 ✓	Vol. max.
Toe Town	0.13		1055	41.0 ✓	Vol. max. sound low
Baabli	0.08		1135	45.8 ✓	sound very low
Tapita	0.064		1220	65.0 ✓	sound very, very lo

LRCN
BOX 2176
MONROVIA, LIBERIA

FIELD INTENSITY MEASUREMENT DATA

STATION: ELRZ

FREQUENCY: 1240 KHz

POWER ND:

POWER DA: 10 KW

LOCATION: Zwedru

RADIAL AZIMUTH: Zwedru to Harper

OPERATOR

POINT	I(MV/M)	DATE	TIME	DISTANCE FROM TX.	DESCRIPTION OF POINT
		6-28-87			
Gbawo Town	5.00		0830	10.0 miles	Sinoe - Maryl Junction
Jeabo	1.60		0850	15.0 ✓	Opposit Churc
Gares Town (Karlor Hwe)	0.39		0925		
Petroken	0.19		1025		
Kawiaken #1	0.12		1105	43.3 ✓	Vol. at mid. sou. with small nois
Putuken	0.04		1145	60.8 ✓	
Kawiaken	0.064		1205	63.3 ✓	
Fish Town	0.04		1245	67.5 ✓	
Sweken	0.02		1445	78.3 ✓	
Harper				134.1 ✓	fading

LRCN
BOX 2176
MONROVIA, LIBERIA

FIELD INTENSITY MEASUREMENT DATA

STATION: ELRZ

FREQUENCY: 1260 KHz

POWER ND:

POWER DA: 10 KW

LOCATION: Zwedru

RADIAL AZIMUTH: Zwedru to Greenville

OPERATOR

POINT	I (MV/M)	DATE	TIME	DISTANCE FROM TX.	DESCRIPTION OF POINT
		6-25-87			
Gbolu	0.315		1050	24.2 miles	In the middle of the two curves
Pynetown	0.235		1225	38.3 ✓	Opposite large unfin. building. Vol. mid
Sangwien	.15		1250	76.6 ✓	Near bridge Vol. max, sound clea
Juazohn	.154		1500	76.6 ✓	Opposite Church Vol. max, sound lou
Pratt Farm (Sayee)	.125		1530	85.6 ✓	Middle of town Sound very, very l
Greenville			1650	110.6 ✓	Fading

LRCN
BOX 2176
MONROVIA, LIBERIA

FIELD INTENSITY MEASUREMENT DATA

STATION: ELRV

FREQUENCY: 585 KHz

POWER ND: 10KW

POWER DA:

LOCATION: Voinjama

RADIAL AZIMUTH: Voinjama to Zorzor

OPERATOR

POINT	I(MV/M)	DATE	TIME	DISTANCE FROM TX.	DESCRIPTION OF POINT
Malamai	5000.00	6-4-87	0915	6.7 miles	Opposite rock
Kelimai	10.00		0920	16.8 ✓	Center of town
Lufata	3.90		0942	16.7 ✓	
Lawa	1.10		1019	23.3 ✓	Near Telecom generator
Luyema	0.80		1035	28.3 ✓	Altco Junction
Konia	0.42		1100	39.2 ✓	Near Coconut tree
Zelimai	0.31		1122		
Borkeza	0.31		1122	46.7 ✓	Center of Town
Fisebu	0.27		1138	51.7 ✓	Near Gas Station
Zorzor	0.23		1145	55.0 ✓	
Sucromu	0.20		1157		Opposite school
Gbanway	0.16		1206		
Salayea	0.12		1225	65.0 ✓	Zolowo Junction Very low & S noisy
Golu	0.10		1250		

LRCN
BOX 2176
MONROVIA, LIBERIA

FIELD INTENSITY MEASUREMENT DATA

STATION: ELRV

FREQUENCY: 585 KHz

POWER ND:

POWER DA: 10 KW

LOCATION: Voinjama

RADIAL AZIMUTH: Voinjama to Sawmill

OPERATOR

POINT	I(MV/M)	DATE	TIME	DISTANCE FROM TX.	DESCRIPTION OF POINT
		6-2-87			
Zewa-damai	4.80		1040	18.3 miles	At the junction of the road
Kpade-mai Junction	2.50		1115	22.5 ✓	
Lisco	1.70		1140		Shopping Center
Sawmill Road	0.90		1150	26.7 ✓	Between the hills.
Sawill Road	0.60		1155		Behind the hills
Sawmill	0.54		1205		

LRCN
BOX 2176
MONROVIA, LIBERIA

FIELD INTENSITY MEASUREMENT DATA

STATION: ELRV

FREQUENCY: 585 KHz

POWER ND: — — —

POWER DA: 10 KW

LOCATION: Voinjama

RADIAL AZIMUTH: Voinjama to Kissidogou

OPERATOR

POINT	I(MV/M)	DATE	TIME	DISTANCE FROM TX.	DESCRIPTION OF POINT
		6-1-87			
Foradu	16.50		1000	6.7 miles	At check point
Mecenta	1.80		1205	28.3 miles	Near Police Station
Bofossou	1.50		1445	20.0 ✓	center of town
Guekedou	0.95		1640		✓ ✓ ✓
Millinou	0.24		1720		Near rice mill town surrounded by mountains
Qualta	0.35		1745		Center of town
Kissidogou	0.28		1815		✓ ✓ ✓

LRCN
BOX 2176
MONROVIA, LIBERIA

FIELD INTENSITY MEASUREMENT DATA

STATION: ELRV

FREQUENCY: 585 KHz

POWER ND:

POWER DA: 10 KW

LOCATION: Voinjama

RADIAL AZIMUTH: Voinjama to Mendekema

OPERATOR

POINT	I(MV/M)	DATE	TIME	DISTANCE FROM TX.	DESCRIPTION OF POINT
Velezala	16.[illegible]	5-30-87	1110	13.3 miles	
Johnsonton	3.5[illegible]		1130	20.0 ✓	Near rock
Kambalahun	1.1[illegible]		1205	25.0 ✓	Near Church
[illegible]hun	1.[illegible]		1235	28.5 ✓	Junction school administrative
Nibwalahun	1.0[illegible]		1250	30.8 ✓	Center of town
Foya Kamara	0.9[illegible]		1320	31.6 ✓	After Police Station
Siello	0.1[illegible]		1408	35.8 ✓	At sign board
Mendekema	0.05[illegible]		1345	41.6 ✓	Check Point

LRCN
BOX 2176
MONROVIA, LIBERIA

FIELD INTENSITY MEASUREMENT DATA

STATION: ELRV

FREQUENCY: 585 KHz

POWER ND:

POWER DA: 10KW

LOCATION: Voinjama

RADIAL AZIMUTH: Voinjama to Vahum

OPERATOR

POINT	I(MV/M)	DATE	TIME	DISTANCE FROM TX.	DESCRIPTION OF POINT
		5-30-87			
Polowu	0.7[illegible]		1518	40.0 miles	Beginning of town
[illegible]	[illegible]		1535	43.0 ✓	50 yard from junction
Karmatahum	0.3[illegible]		1605	49.3 ✓	Center of town
Yadehum	0.[illegible]		1645	55.0 ✓	✓ ✓ ✓
Gondama	0.1[illegible]		1730	60.8 ✓	✓ ✓ ✓
Mino	0.15		1740	64.0 ✓	✓ ✓ ✓
Vahum	0.16		1750	66.7 ✓	✓ ✓ ✓ Vol. control maximum

ELWA
P.O. Box 192
Monrovia, Liberia

FREQUENCY SCHEDULE

FINAL SECHEDULE: 5 MARCH ('89) TO 30 APRIL 1989 (M'89 SEASON)

TENTATIVE: 7 MAY 1989 TO 31 AUGUST 1989 (J'89 SEASON)

Freq (kHz)	Meter Band	Time GMT	Transmitter Power (kW) / Azimuth (o) / Antenna Type	Zone / Language
711	422	0505-0802 Daily except: 0505-0817 Friday 0505-1200 Saturday 1555-2230 Saturday 0655-2230 Sunday 1555-2230 Weekdays	10 / ND / VERTICAL	Liberia / E
3233	90	0610-0802 DAILY 1805-2210 Daily except: 1805-2150 Friday	10 / ND / TROPICAL	Liberia / W
4760	60	0555-0802 Daily except: 0555-0817 Friday 0555-0832 Saturday 0655-0832 Sunday 1725-2230 Daily	10 / ND / TROPICAL	Liberia / E Liberia/W,E
6070	49	1555-1800 Daily 1800-2045 Daily 0825-1600 Saturday-Sunday	10 / 097 & 325 / HS 50 / 097 & 325 / HS 10 / 097 & 325 / HS	46/ F, W 46 / F, W
7270	41	0830-1830 Daily	10 / 097 & 325 / HS	Liberia / E
9550	31	1200-1330 Daily	50 / 097 & 325 / HS	46 / F, W
11830	25	0630-1000 Sat./Sun./ 1240-2205 Sundays 1555-2205 Daily/Saturdays	50 / 081 / HR	46,/ 47 / E, W 46, 47 / E, F, W, E
11910	25	1525-1700 Daily	50 / 018 / HR	37 / A
11955	25	0655-0815 Daily	50 / 018 / HR	37 / A

Geographic Coordinates:
06 N 14'; 10 W 42'

Abbreviations:
ND = Omnidirectional
HS = Horizontal Slewed
HR = Horizontal Reflector

Zones:
37 = North Africa
47 = Central Africa
46 = West Africa

Languages:
A = Arabic
F = French
W = West African
E = English

Radio Primer for Development Communications
by Kim Aubry

Prepareo for Primary Education Project, Minstry of Education;
Academy for Educational Development, U.S. AID
January. 1989

What follows is general background on some of the radio technology and terminology used in radio broadcasting. This is intended to be an aid for non-technical people who would like to better understand radio especially as it is used for education in the developing world.

Medium Wave (MW) Refers to the "band" of radio frequencies we normally call "AM" in the U.S. As opposed to Short Wave or the less commonly used Long Wave. Medium wave transmission uses Amplitude Modulation (AM) and is susceptible to noise (interference and static) in urban areas and in areas too far from the broadcast transmitter. Medium wave transmission is typically unaffected by terrain, as the radio waves tend to "bend" around obstructions (hills, valleys and to some degree, the horizon) and is therefore a good choice for broadcasting in hilly terrain. The MW band is 535 - 1605 kiloHerz. AM transmitting antennas are not necessarily situated in high places; the "conductivity" of the soil is a more important consideration so it is not uncommon to find AM transmitting antennas located in marshland at sea level.) Quality of reception of MW stations can change with time of day, especially in "fringe" reception areas. (The signal may become too "noisy" to be intelligible especially close to the noon hour.)

Short Wave (SW) Refers to many "bands" of frequencies that are used primarily for long-distance communication. SW transmissions use transmitting antennas that aim the radiowaves upwards towards the sky where the waves bounce off a layer of the atmosphere called the ionosphere. By using the sky as a "reflector," programs can be transmitted considerably farther than when using either Medium Wave or FM (VHF) frequencies. Because the ionosphere is in a constant state of change, affected by the sun, air temperature, season and sunspots, it is often difficult to predict how reliable SW reception will be at any given time. Different SW frequencies work better at different times of the day, and so shortwave broadcasters will change frequencies several times in the course of the day to take advantage of the most effective frequency at the time. Short wave receivers are often described by the "number of SW bands" they receive. Most will pick up all commonly used SW frequencies; the more expensive ones divide up the frequencies into a larger number of bands to make tuning more precise. On an 8-band receiver, there is more space on the dial between stations than on a 2 or 3-band set, so it will be easier to find the desired station.

49 Meter Band Refers to a particular band of frequencies on shortwave. In the old days, radio stations were described by their "wavelength" rather than their "frequency" (ie 11 meter or 41 meter) This expression is a carryover from that time. For example, the BBC may announce: "We now move from 15.4 Megaherz, on 19 meters to 9.6 Megaherz on 31 meters." It will help the shorwave listener select the correct "band" on their receiver before tuning to the correct frequency.

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AM or Amplitude Modulation is a technique for transmitting sound using radio waves. It is the older method of radio transmission and it is inherently sensitive to noise and static (in the receiver) caused by either manmade or atmospheric disturbances. (Vacuum cleaner motors, lightning, power lines, etc.) AM is used in both MW and SW broadcasting. In common useage, the terms "AM" and "Medium Wave" mean the same thing.

FM or Frequency Modulation is the newer technique for transmitting sound using radio waves. It is inherently immune to noise and static; therefore, it may provide superior receiver sound quality in "fringe" reception areas. FM is used exclusively on **VHF** frequencies. (The FM band is 86 - 108 MHz) This band is much higher in frequency than bands used by either MW or SW, and this band has different characteristics. It is strictly a "line-of-sight" medium meaning that there must be no major obstruction (topography or large building) in the path from transmitter to receiver. Under ideal conditions, the FM station will reach as far as the horizon (curvature of the earth) which will depend on the height of the transmitting antenna. Generally, FM transmitting antennas are situated on mountaintops, and may have a coverage radius of 35 to 50 miles. These days, most receivers including inexpensive ones are capable of receiving both FM and MW-AM bands. FM is capable of higher audio fidelity (better sound quality) than AM (MW or SW). For most speech based programs, AM is adequate, provided the listener is getting a strong enough radio signal. Only FM is used for stereophonic broadcasting.

Fading This describes a kind of radio reception where the sound seems to come and go in loudness and quality. Fading is most apparent with shortwave broadcasts, especially when the atmospheric conditions are changing (sun is going up or down, etc.) Fading can be very distracting when it is pronounced; sometimes, you can reduce it by repositioning your receiving antenna, or by using a different type of antenna.

Skywave Although the intended "primary" audience for MW broadcasts receive "groundwave signals" (radio wave signals coming into the listener's set in a direct line from the transmitting tower) sometimes, especially at night, people may get "skywave signals" which are MW signals that have bounced off of the ionosphere and are picked up back on earth at a great distance from the transmitter (as in shortwave reception). Sometimes, there is an area just beyond the radio transmitter's main coverage area where there is no reception of "groundwaves" and no reception of "skywaves." This is called the "skip zone" because the radio waves have skipped over this area.

Transmitter Power The more powerful the transmitter, the further the radio station's signal will carry. Transmitter power is expressed in watts or in kiloWatts which are thousands of watts. A 20,000 watt (20 kW) station will **not** reach twice as far as a 10,000 watt transmitter. In very rough terms, one must increase a transmitter's power by a factor of 10 to double its reach.

Field Strength It is possible to measure a radio station's coverage by using a meter that tells us the "field strength" at a particular location. By making measurements like this (MW or FM), we can predict whether or not an average consumer radio will work well at a given distance from the transmitter. Field strength is expressed in millivolts per meter.

2b

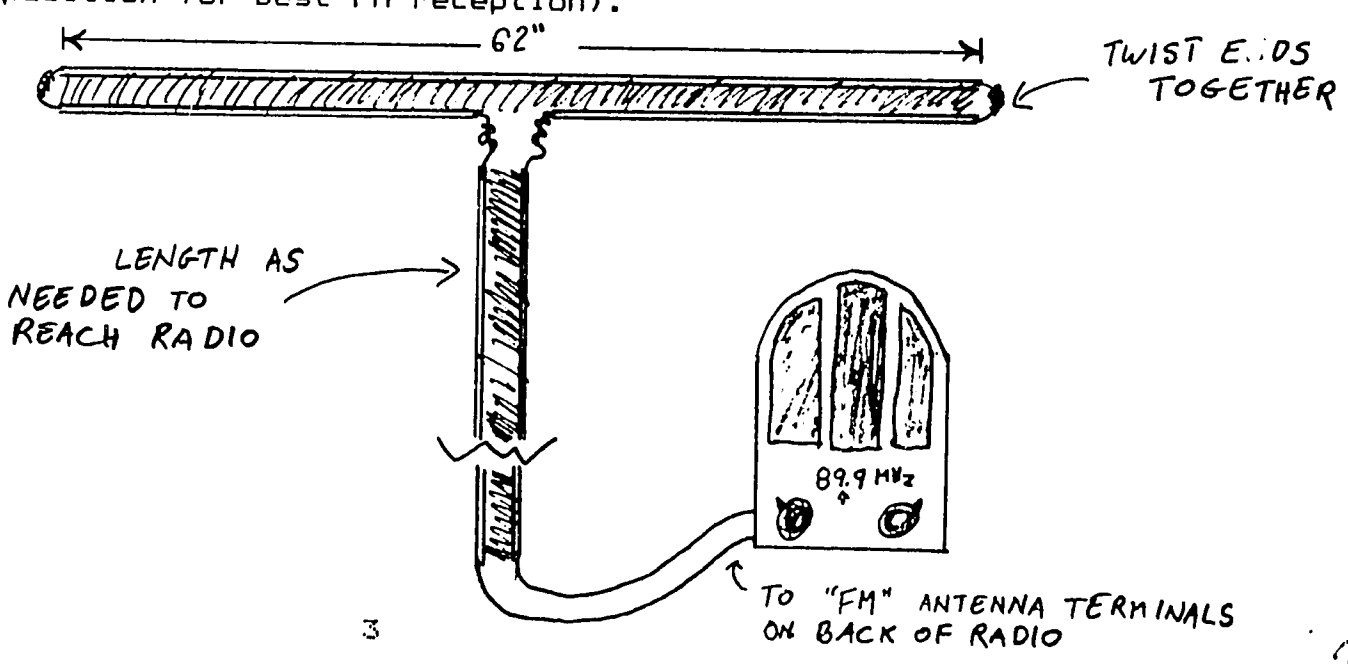
Receiving Antennae There are several types of receiving antennae used to pick up MW (AM), SW and FM signals. Sometimes, combination receivers (AM/FM/SW) provide more than one kind. Here is a brief discussion:

MW Antenna The Ferrite Bar antenna is the most common type; usually, you don't see it, its built into the receiver. The Ferrite Bar is quite directional, the way to aim it is to position the radio itself for the best (loudest and least noisy) signal. Usually, even though the radio has a telescoping "wand" antenna, only the built in Ferrite is connected when you are in the MW mode.

If the Ferrite Bar doesn't work well enough, you can try to improve the reception by connecting a very long piece of wire (200 feet +) to either the radio's "AM Antenna" terminal, or to the radio's telescoping antenna. Run the wire in the direction of the radio station's transmitter (use a compass and a map) and stick the far end of the wire into the ground. Try to keep the length of the wire a few feet above the ground (you can tie it from tree to tree). Obviously, this will only work in a rural area.

SW Antenna Use the telescoping wand for starters. Try extending it horizontally, and try to keep the radio itself off the ground. If the built in telescoping wand doesn't work well enough, try taking a length of wire (10 - 25 feet long) and run it between the radio's SW antenna terminal and the other side of the room on the wall at least 2 feet off the ground; you can use a piece of tape. If there is no SW antenna terminal on the radio itself, you may try simply wadding up the end of the wire and tying a knot around the telescoping wand.

FM Antenna Usually, a portable radios' FM antenna is either a telescoping wand, which should be extended horizontally, then aimed for best reception; or in the case of a Walkman, the headset cord itself. You can make a simple "folded dipole" receiving antenna that works well on FM by taking a 62" long piece of "ribbon wire" (aka "300 ohm antenna wire" available at an electronics supply store) and preparing it as follows: This antenna is quite directional; it should be hung on the wall or outside in a manner so that the length of the ribbon is in a line perpendicular with an imaginary line from the radio station's transmitter.
(Adjust position for best FM reception).



APPROPRIATE TECHNOLOGY FOR DEVELOPMENT COMMUNICATORS

Many of you are employed by ministries or N.G.O.'s that wish to make use of radio to disseminate their development messages. I have prepared some informal notes to assist you in recommending equipment for these purposes. All of the following gear was selected because it:

-Is fairly robust (it won't go faulty in normal to rough applications);

-Is fairly simple to operate by professionals like you;

-Will make it possible to make good-quality recordings.

I: Field recording, sound gathering.

Microphone type: Dynamic Omni-Directional with good rejection of handling noise, and good rejection of wind noise; rugged construction.

Recommended: Electo-Voice DO-56-L or Electro-Voice RE-50. (Both U.S. made. Price in U.S. $ = $125 - $175 you will need an external wind-screen for the DO-56) Shure SM-61, Audio Technica AT-814-A ($125 US)

Remember, we recommended against using uni-directional or cardioid type microphones in the field; they are always more sensitive to wind and handling noise and are more difficult to get consistent levels with.

Accessories for Mics: Shock mount: Electovoice 313-A. "C-Clamp" made by Atlas Sound (U.S.) is very useful. Mic cable (cord): These must be custom made according to your requirements: The microphone end nearly always requires an XLR-Female type connector; the tape-recorder end will require either 1/4" phone; XLR-Male or 1/8" mini. (Note: some portable stereo recorders require the recently introduced 1/8" stereo mini connector!) The cord itself is ideally a "retractile" type, like a telephone hand-set's. It must be "well shielded" with a twisted pair inside. (U.S.-made Belden #9499 is ideal for the purpose).

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Portable Cassette Recorder This battery operated cassette recorder should have the following:

- -Ability to record without AGC (automatic gain control).
- -Headphone jack that works in record-mode (for monitoring).
- -Tape Counter (for logging)
- -Mic. Input Jack.
- -Good audio quality.

Some nice but non-essential features include:

- -Line level input jack(s).
- -Limiter that can be switched on and off.
- -Three-head operation.
- -Dolby or dBx noise reduction.
- -Stereo recording capability.
- -Pitch-control (allows slowing down or speeding up in playback mode only, used on playback on recordings made when batteries had started to go flat.)

Recommended:
Sony still makes the "TC-D5 Pro," though it is very expensive. ($900 U.S.). (Has Dolby, limiter. stereo, XLR Mic Input Jacks);

Sony also makes an in-expensive "Pro Walk-man" called the WM-D6C. It is not well-suited for professional recording: it has no limiter; Vu meters that are very difficult to see and no built-in loudspeaker, though it can make excellent quality recordings when use properly and it is exceedingly light weight. May be a good "back-up machine," it has 1/8" "stereo mini" jacks for headphone, microphone and line-input. ($350 U.S.)

Marantz makes 2 recorders worth looking into: The more expensive one is the "PMD 430." It is a stereo recorder that has Dolby noise reduction, three-heads, limiter, and excellent audio quality. It is like a less expensive TC-D5 Pro, except it does have line level inputs. Not quite as rugged as the D5 though. ($400 U.S.)

Strong Recommendation:
They also make a machine "designed with us in mind." Its called the PMD-221, and it is a small lightweight rugged mono recorder with good audio quality. It has a choice of AGC, limiter or fully manual (selected by switch); three-heads, easy to use Vu meter and good price. (Around $300 U.S.)

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Portable Open Reel Machines
I won't say much about these; they are all very heavy to carry around, and more susceptible to breakage; they use 5" reels which only hold 15-20 minutes of professional 1.5 mil tape at 7.5 IPS. But they do offer the advantage of not having to dub for editing purposes. (Good for recording a speech that you want to put on the air soon after recording). Uher Report 4000, Sony Nagra and Stellavox are all professional quality, none are cheap.

Useful Accessories for Portable Recorders
AC Mains adapters (220 Volts with your kind of plug installed) are useful to conserve batteries. Don't forget various audio adapters to permit you to plug in various types of cables from other "line-level" sources. Of particular value are adapters that change: RCA (phono) to 1/4" Phone; RCA to Mini; RCA to DIN, 1/4" Phone to Mini and 1/4" Phone to Din. Don't forget spare mic. cables (they are the most likely to go faulty in regular use) and cotton buds with alcohol for head cleaning. You may want to get a water-proof nylon "camera case" in which to put your microphone, cassette machine, spare cassettes, batteries, headphones, cables and adapters. This will help organize your equipment, and will make going out on-location less of a chore.

Headphones Monitoring on headphones is recommended for all recordings when you are using a microphone. (Remember, without headphones, you have no idea what is **really** going on the tape.) The general type you want to buy are the "closed ear" variety; not the foam super-comfortable "Walk-Man" type. This is because the "open foam" type do not isolate you from the room sufficiently to be able to tell what you are hearing through the headphones and what you are hearing directly with your ears.

Sony, Beyer and Koss all make closed headphones. Sennheiser makes high quality open headphones. Some headphones come with 1/4" stereo phone; some with 1/8" stereo MINI. (Some may come with the DIN headphone connector). Try to buy the type that will best match the connector on your recorder; adapters will work but they tend to go faulty or scratchy sounding after time passes.

Recommended: Sony V-4, V-5 or V-6; Sony MDR Series, Beyer DT-220, AKG K-141.

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II - The Studio If your employer will be building a small production studio (or adding to an existing one) here are some recommendations:

Professional Open-Reel Recorder
Otari MX-5050 B-II is the best all-around (moderate cost) production and editing machine: It has 3 heads; real-time tape counter; editing facilities; built in tone generator for alignment and maintenance. It is easy to use and repair. (U.S. $2,000)

Also worth considering is Studer PR-99. Stay away from "bargain" semi-professional equipment. It is usually difficult to edit on, and difficult to maintain.

Studio Accessories
Edit Block: Model S-3 from Xedit Corporation.

Splicing Tape: Scotch Type 41 or 67 work best. (7/32" wide)

Leader Tape: Paper or plastic. (Not Clear!)

Marking Pencils: China Markers or Wax Pencils

Empty Spools: A selection of 7" and 10 1/2" empty spools are essential.

Recording Tape: Must be 1.5 mil thick. (7" reel 1,200 feet at 7.5 IPS = 30 minutes; 10 1/2" 2,500 feet reel at 7.5 IPS = 1 hour)

Scotch: 806, 250
Ampex: 406, 456
Agfa: PEM 468, 469, 568

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Cassettes:
If your cassette machine(s) have a switch for the "high bias" type tapes (Chromium Dioxide), then you will get noticeably better sound using type II (CR O2) cassettes:

	Type I	Type II
Excellent:	Maxell XL-IS or TDK AD-X	Maxell XL-IIS or TDK SA-X
Very Good	Maxell XL-I	Maxell XL-II or TDK SA
Good:	Maxell UDS-I or TDK AD	Maxell UDS-II

Remember, cheap cassettes are seldom a bargain; they sound hissy, have drop outs and jam more frequently. You will probably be using cassettes several times before throwing them away, so it is worth your ministries money to invest a little more for better sound.

Stay away from 120 minute long cassettes; the tape in these is very thin and can easily stretch and jam. 90 minutes maximum!

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