HIGH FREQUENCY RADIO
COMMUNICATIONS ASSESSMENT
FOR THE
SENEGAL CROP PROTECTION SERVICE

December 1988

This High Frequency Radio communications assessment was prepared for the Office of Foreign Disaster Assistance, U.S. Agency for International Development under contract FDA-0000-0-00-9002-00.

Prepared by: Donald Smith
ASC & Associates
Radio Communications Consultants
647 West Highway 50 (O'Fallon Centre)
O'Fallon, Illinois 62269

HF Radio Communications Assessment

Crop Protection Service
Republic of Senegal

Traveler: Donald R. Smith

Days of Travel: 21 November - 4 December 1988

Country Visited: Republic of Senegal

Purpose:

To design a radio system to support the grasshopper and locust control operations for the government of Senegal. Specifically to:

- assess the immediate and short term communications equipment needs for the Crop Protection Service (CPS) for Locust and Grasshopper control operations including, but not limited to land mobile, aeronautical mobile, and aeronautical navigational requirements.

- identify and provide written specifications for equipment, including installation specifications.

- review and rate local, and if necessary, regional firms on their ability to install and maintain the recommended equipment.

- provide a short training outline for users. This can be based on manuals provided by the contractor which may be translated and distributed locally.

Itinerary:

APPENDICES:

1 - Points of Contact
2 - Propagation Predictions and Frequency Requirements
3 - Equipment Specifications
4 - Installation Procedures
5 - Users Training Guide
6 - Technical Assistance Communications Requirements

21 Nov. - 23 Nov. 88 Dakar, Senegal - Received in-country, status of Desert Locust control operations, and visited Operations facilities at Yoff International Airport. Reviewed available communications supporting the technical assistance team and aircraft operations.

25 Nov. - 3 Dec 88 Dakar, Senegal - Reviewed Crop Protection Service (CPS) radio assets and visited CPS facilities. Discussed radio operations and communications maintenance problems. Visited local communications-electronics maintenance facilities within the area.

Site Visits:

Dakar, Senegal - During the visit to the Desert Locust operations facilities an overall communications assessment was made. Based on discussions with technical assistance team personnel, contractor personnel and review of available communications assets communications is marginal for operations. At the operations site the only communications available was a single radio on the Embassy "B" net and a handheld air/ground radio. The Embassy net is a simplex net, no repeater is available. With the operations area 18 miles from the base station located at the embassy, communications with other personnel was marginal at all times. The radios installed in the vehicles were adequate but the antenna installations were extremely poor. Antennas were mounted on the hoods of the vehicles causing unnecessary shielding and increasing the ambient noise levels of the radios. The antennas were not adjusted to frequency which reduced transmit and receive effectiveness and range. No HF communications was available at the operations site preventing coordination with aircraft during operations. There were no HF radios installed in survey vehicles which required return of the survey teams each night to obtain the survey information. The typical survey day as a result was fourteen hours on the road. The only HF communications used were Yaseu Amateur radios. One was installed at an ADO's residence and the other was located at the Desert Locust operations office in St. Louis, Senegal. The radio was monitored three times a day to pass necessary information. The antenna installation at the ADO residence was marginal with an off-center dipole feed with a MAXCOM tuning device. The antenna was elevated only two feet above the metal covered roof. A description of the antenna installation at St. Louis was not favorable although it was not possible to verify the information. Three other Yaseu radios were available. Of the two operational radios, one was placed in temporary use from a temporary locust control team location. There were inadequate facilities to install anything much more than a marginal system with the short time available. The handheld radios were of limited use in large aircraft operations. With the speed of the aircraft by the time they were in range the aircraft antenna,

located on top the fuselage, was shielded from the handheld radio. Additionally, the sensitivity of the aircraft receivers was typically 3 - 6 microvolts. This further reduced the effective range of the handheld radio.

Dakar, Senegal - Discussions were held with personnel of the Crop Protection Service (CPS) on communications operations, maintenance, and training problems. Several areas of major concern were identified. The first is maintenance of available HF radios. At the present time there are seventeen inoperative radios. One Icom 735, fourteen Sideband Associates SBA 302-TAC and two Thompson TRC-495 radios. Of these the only known source of repair is for the Thompson TRC-495s. Personnel need to be trained to install and maintain the HF radios available. Operators require a standard training course to effectively use the HF radios. The requirement for specific operating information is further complicated by the numerous types of radios in use. Another significant problem is the lack of proper frequencies to support the total CPS radio network. At present available frequencies are 5121 KHz and 9149 KHz. With the base station, five service stations, ten region offices, 27 department offices, and nineteen vehicles this is a marginal situation. The CPS has established a heirarchial time schedule of operations to obtain the most effective use of the existing frequencies. While this is marginally adequate at this time, as additional mobile radios are installed the timely flow of information will breakdown. This will reduce the timeliness of the field survey information and reduce treatment effectiveness.

Available electronics maintenance facilities capable of servicing HF transceivers are limited. The majority of the facilities service only home entertainment equipment and lack the necessary test equipment for communications equipment maintenance. The primary communications maintenance organization is Thompson-CSF. This is a regional dealer and service center for Thompson communications equipment. This facility has maintained and installed numerous other makes and models of equipment within the region including the solar powered HF radio installations for the Commissariat du Securitate Alimantare (CSA) warehouses in Mauritania.

Lessons Learned: N/A

Conclusions:

1. Communications is an essential element in effective use of technical assistance teams and agricultural spray aircraft for Desert Locust control operations.

2. Communications equipment, technical knowledge, and

skills are not available within the AID mission organization. Embassy communications personnel may or may not have the necessary skills in radio communications to advise or assist in meeting the operational communications needs.

3. The communications equipment and systems required to support temporary operations are not necessary to normal AID mission operations.

4. Use of existing USAID frequencies and communications equipment to support Desert Locust operations is inadequate to provide the required communications.

5. The lack of a land mobile administrative/logistics radio system resulted in lost man-hours, delays in operations, unnecessary use of vehicles, and difficult coordination with mission personnel.

6. Lack of adequate communications between field survey teams, spray aircraft, and operations personnel limited the overall effectiveness. HF radios available were inadequate in type or quantity.

7. The CPS has established a network architecture and radio network to effectively use available radio assets.

8. The use of alternative power (solar) sources for the radio network is an outstanding use of resources.

9. There are insufficient frequencies available to the CPS for full development of their radio system.

10. Some of the radio equipment on hand is non-maintainable. Sideband Associates is no longer in business and maintenance support of those radios is unlikely.

11. The variety of radios being used contributes to the difficulty in training personnel in radio operations procedures.

12. The use of HF amateur radios is a major factor in training of operators and locating suitable radio maintenance facilities.

Recommendations:

1. When forming technical assistance teams to conduct Desert Locust control operations appoint a single manager for overall operations. The manager and key personnel should identify all communications requirements and equipment prior to leaving for the operations location.

2. As a minimum, communications should consist of an

administrative/logistics support net and communications between operating locations, field survey teams, and spray aircraft.

3. After identifying communications requirements, forward a request to the host country, through diplomatic channels, for radio frequencies to meet these requirements.

4. All aircraft operating in support of Desert Locust operations must have operable low frequency/medium frequency automatic direction finding and HF radio communications capabilities. Aircraft flight following communications must be available during aeronautical operations.

5. Appropriate installation and operations training materials must be available to train personnel installing and using communications equipment.

6. All communications and navigation equipment should be acquired and shipped from the US. Availability of supplies and equipment in the host countries is questionable. For long term operations provide spare equipment or repair parts with the equipment packages.

7. Provide a communications technician to accomplish the necessary training and install equipment. Long term operations may require a maintenance technician.

8. The CPS should request additional frequencies from the Office of Posts and Telecommunications (OPT) to support the existing network. Typical propagation predictions and required frequency ranges are included in Appendix 2.

9. Replace the Sideband Associates radios with appropriate HF radios and ancillary equipment. Additional radios are required to meet essential communications requirements. Equipment specifications furnished in Appendix 3 reflect the technical characteristics necessary to support the existing architecture and HF radio network.

10. Provide solar panels for charging of batteries at all fixed locations. Adequate sunshine is available to maintain the electrical charge for battery operation. This will eliminate problems caused by unreliable power.

11. Provide all maintenance and instruction manuals in the French language version or have the manuals translated by a person versed in communications verbiage. Local translation of technical manuals may not be effective.

12. Assist in the reproduction and distribution of the installation, maintenance, and radio operating procedures furnished in Appendix 4 and 5.

APPENDIX 1

POINTS OF CONTACT

Ambassador Moose	US Ambassador to Senegal
Sarah Jane Littlefield	AID Mission Director
James Bonner	ADO
David Robinson	ADO
F.M. Phillips	Entomologist
George Gavin	Entomologist
Charles McDonald	Air Operations Officer, USFS
Rudy Tantare	Air Operations Officer, USFS
Gordon Orloff	Operations Officer, BLM
Alan Mudge	Entomologist, Oregon Forest Svc
Firmin Nyouki	Director of Communication, CPS
Ousmane Camara	Communications Officer, CPS
Seyni Dieme	Technical Advisor, CPS
Seydori Ba	Radio Operator, CPS

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1 Frequency in band 9040-9500 KHz
Operating Locations: Country wide

For the Air/Ground Support Sub-Net:

User: Crop Protection Service

Emission: 3K00J3E Power: 100 Watts

Station class: MO

1 Frequency in band 5680-5730 KHz

1 Frequency in band 8965-9040 KHz

Operating Locations: Country wide

Separate nets/sub-nets are required to permit multiple operations simultaneously within the country and still provide reliable communications.

1'

APPENDIX 2

PROPAGATION PREDICTIONS
AND
FREQUENCY REQUIREMENTS

The frequencies currently in use by the CPS are inadequate to meet the communication requirements of the CPS.

Typical propagation predictions were prepared to identify necessary frequency ranges for CPS operations. These predictions along with the existing concept of operations define the requirements.

Frequency requirements should be submitted through appropriate ministerial channels to the OPT for necessary action. The following technical information is furnished to assist in frequency assignment action:

For the CPS Headquarters/Regional/Departmental Net:

User: Crop Protection Service

Emission: 3K00J3E Power: 100 Watts

Station class: FX

1 Frequency in band 3200-3400 Khz

1 Frequency in band 5060-5480 KHz

1 Frequency in band 7300-8100 KHz

1 Frequency in band 10150-11275 KHz

Operating Locations are: Country wide

For the Departmental Operations Sub-Net:

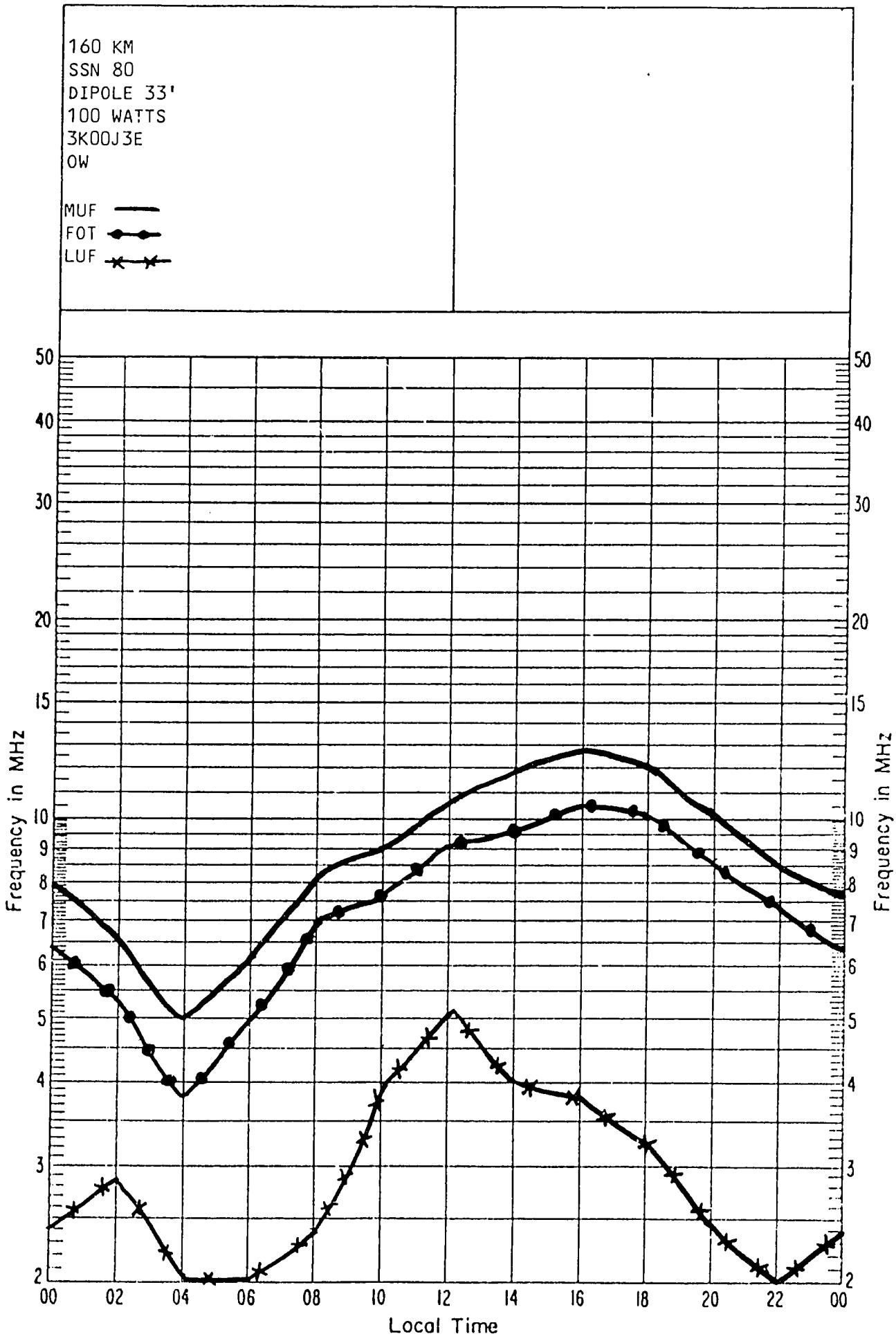
User: Crop Protection Service

Emission: 3K00J3E Power: 100 Watts

Station class: FX/MO

1 Frequency in band 4750-4995 KHz

1 Frequency in band 6765-7000 KHz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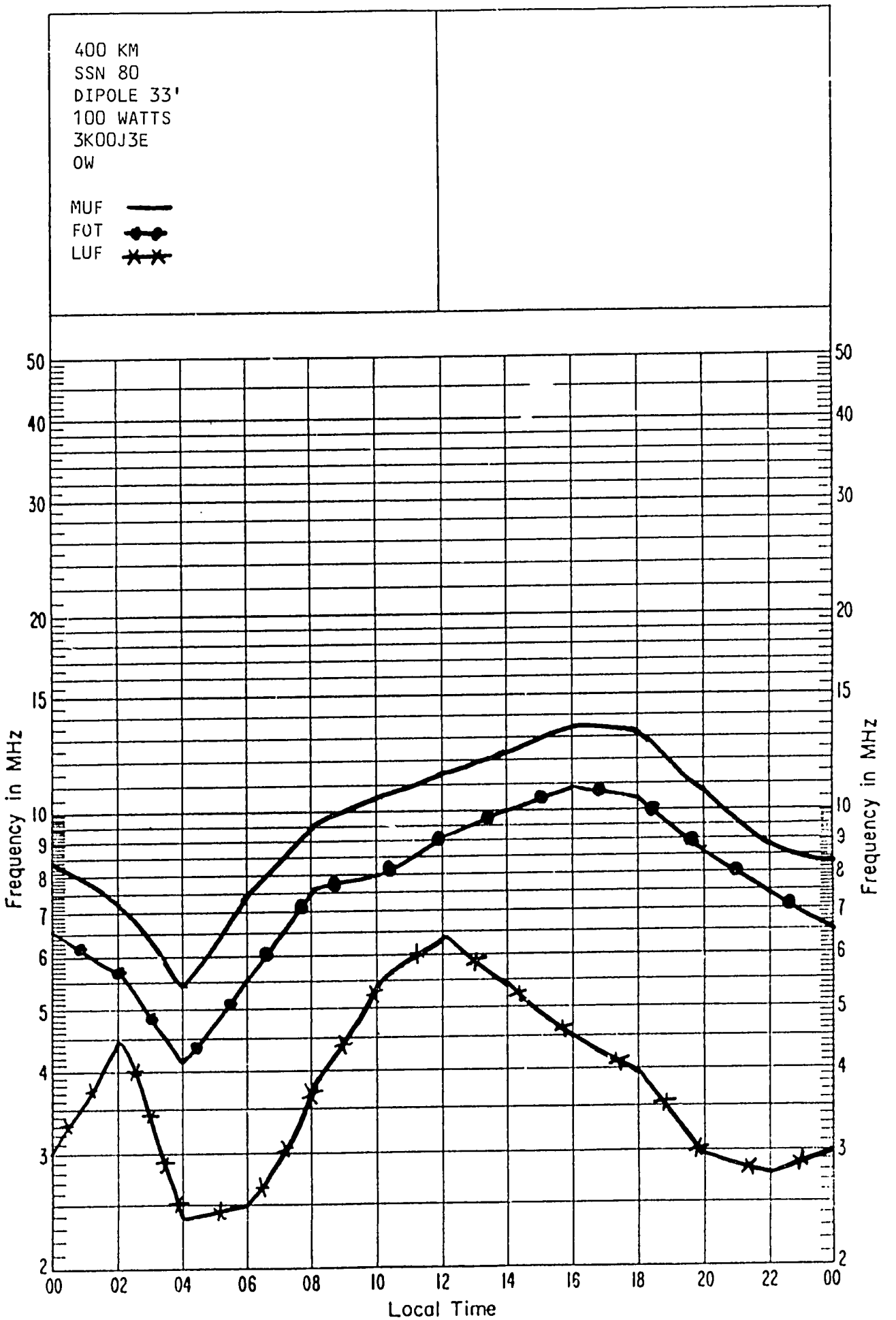
Local Time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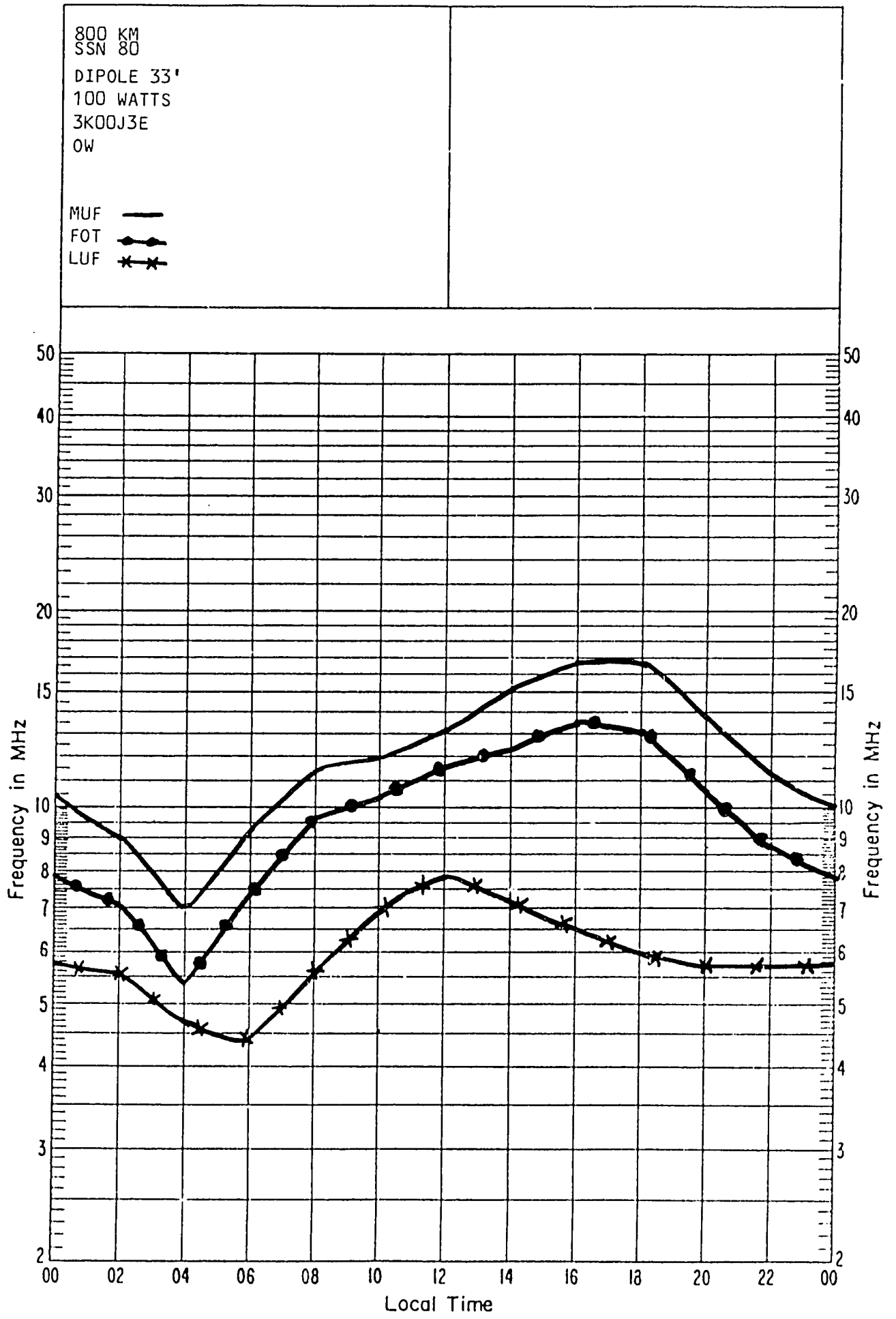
800 KM
SSN 80
DIPOLE 33'
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APPENDIX 3

EQUIPMENT RECOMMENDATIONS

The following communications equipment recommendations are made to support the Crop Protection Service HF network. These recommendations are made to:

1. Provide equipment meeting the minimum essential requirements

2. Provide equipment that is both easy to operate and maintain in the normal operating environment

3. Simplify installation and maintenance procedures

4. Simplify operator training

RADIO:

High frequency single sideband radio, tuning range minimum 3 - 12 MHz, output power 100 watts PEP minimum, upper and lower sideband capability, minimum 4 channel fixed frequency operation, with noise blanker, hand microphone, and mobile mounting bracket. Radio must have a minimum of operating controls. Radio must operate on 13.8 VDC. If radio is programmable, access to programming controls must be restricted from users.

ANCILLARY ITEMS:

Mobile antenna tuner, capable of tuning any frequency used by the radio.

Mobile antenna, 9 foot steel whip

Mobile antenna mounting bracket, with spring

Broadband Dipole Base station antenna covering the frequency range of the radio

Battery charger, solar powered with float regulator or

Battery charger, 220VAC input 13.8VDC output

Parts repair kits should be provided to support the radios acquired if a maintenance capability is available.

APPENDIX 4

INSTALLATION PROCEDURES

Several installation procedures have been developed to assist in the establiishment of the CPS HF radio net. Recommend that this procedures be translated to French language. Reduce in size to 5 X 7 inches. Laminate and distribute to all personnel involved with the installation and maintenance of the CPS HF radios.

1 - Fixed Station Battery Installation

2 - Fixed Station Antenna Installation

3 - Mobile Radio Installation Tips

FIXED STATION BATTERY INSTALLATION

1. Batteries for fixed operations must be 100 AH capacity.

2. Locate batteries in a well ventilated area.

3. Fasten battery chargers securely to a wall near the battery location.

4. Wiring between the battery charger and the battery should be 10 gauge or larger.

5. Post warning signs at each battery location.

" NO SMOKING, MATCHES, OPEN FLAME, OR SPARK

PRODUCING DEVICES WITHIN 10 METERS"

6. All battery terminals and connections must be clean and free of corrosion.

7. Install connectors and wires to the battery. Tighten securely and then apply a thick coat of grease to the terminals and connections to prevent corrosion.

8. Check battery liquid levels once each week. Remove the caps from each cell and check the level. If the level is below the fill indicator, add distilled water until the level is at the fill indicator.

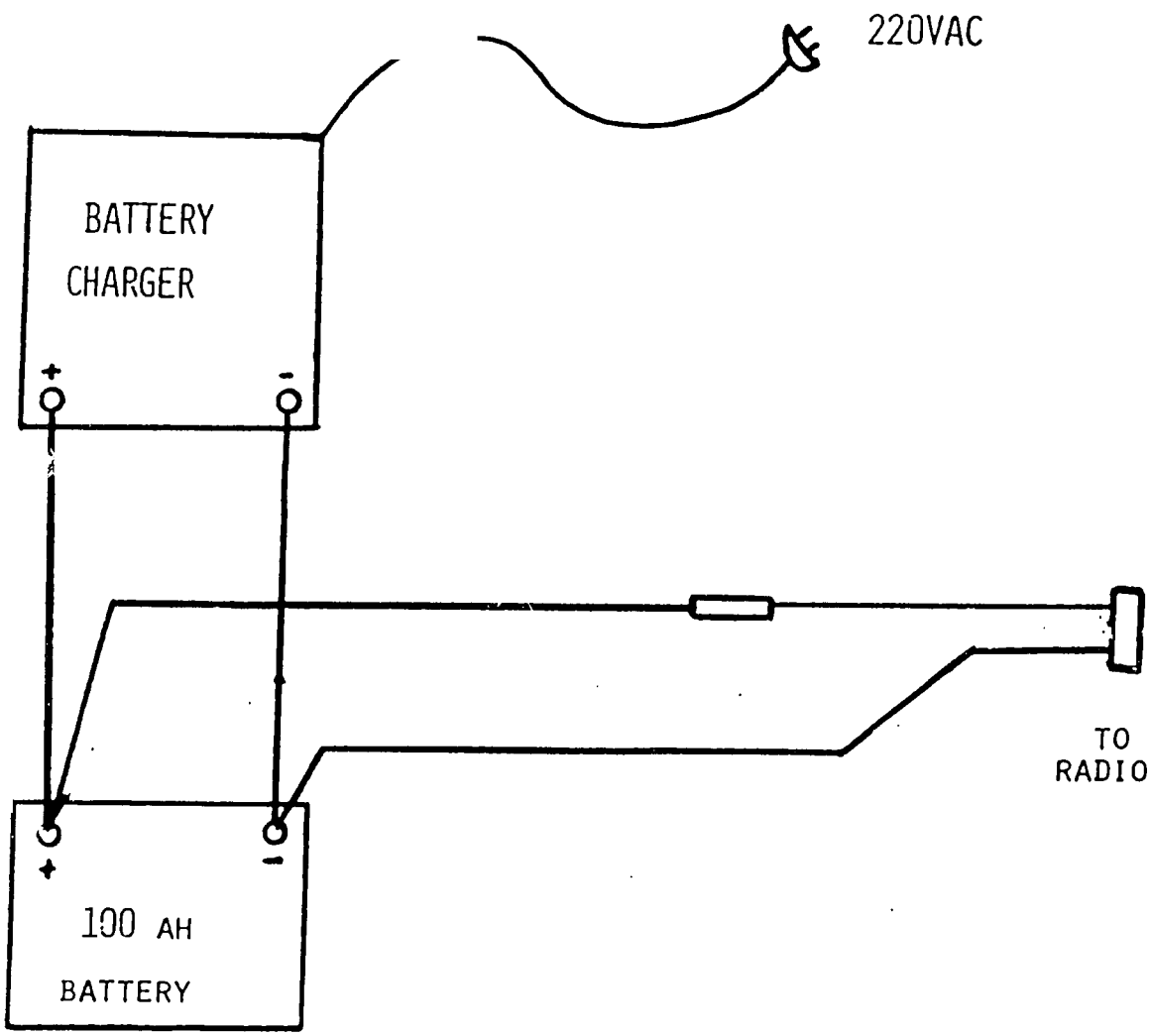
"C A U T I O N"

Battery solution is extremely corrosive. Do not get the solution on skin, eyes, or clothing. If the solution is spilled on you seek immediate medical attention.

9. Operate the battery charger at all times except when servicing the battery or when making connections to the battery.

10. After each six month period, check the battery solution with a battery hydrometer. If the solution is not correct, have a battery technician service the battery.

BATTERY INSTALLATION DIAGRAM



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FIXED RADIO ANTENNA INSTALLATION

1. Antenna poles must be no closer than 15 meters to electric power wires.

2. The distance between the antenna poles should be 2 meters greater than the length of the antenna.

3. Antenna must be 6 and 10 meters above the ground and 10 meters from the nearest building.

4. The antenna support wires will have insulators installed as shown on the drawings.

5. Place anchors for the antenna support wires 4 -8 meters distant from the antenna mast base. Anchors for antenna support wires are typically placed at a distance from the tower base of 65 - 75 percent of the tower height. Since the mast height is specified as 6 to 10 meters, the anchor distance is specified as 4 - 8 meters.

6. Drive a ground rod 3 meters in length into the ground at the base of the antenna mast.

7. Connect the antenna mast and ground rod with 2 gauge wire or larger.

8. Details of the antenna base, antenna support anchors, and installation details are shown in the diagrams.

9. The coaxial cable must be at a 90 degree angle to the antenna.

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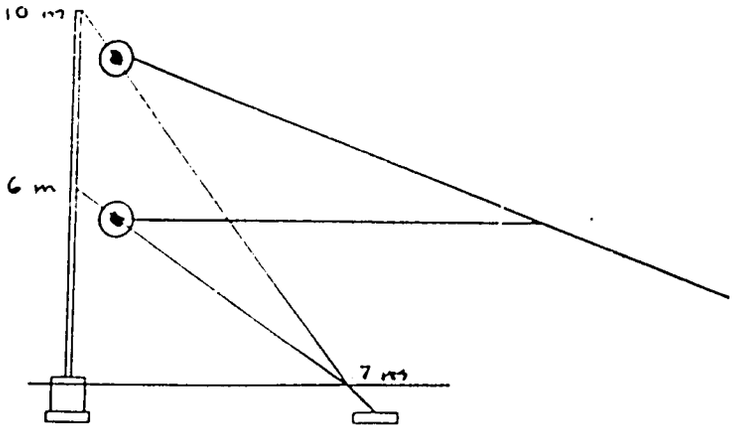
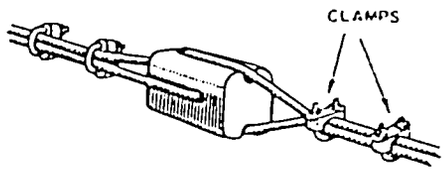
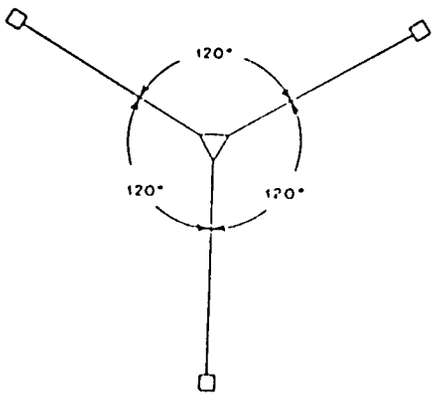
ANTENNA INSTALLATION DIAGRAM







MOBILE RADIO INSTALLATION TIPS

1. Mount the radio in a suitable location that will permit access while the vehicle is in motion. The location must protect the radio from damage, and not offer a hazard to the driver or passenger. Specific location, drilling, and fastening information was not furnished due to variations in the vehicles utilized. Installation instructions are furnished with the radio mounting kits on placement and sizes of mounting holes.

2. Locate antenna mount where it will not interfere with other mounted equipment.

3. Install the antenna coupler as close to the antenna mount as possible.

4. Route all power wires directly to the battery.

5. Where wiring must pass through walls, use protective grommets. If necessary to preserve watertight integrity, use bulkhead connectors.

6. Use correct size cable clamps to hold wiring in place and protect from abrasion.

7. Install appropriate RFI suppression devices on the vehicle. With the varying makes and models of vehicles being used, specific radio frequency interference suppression devices were not identified. The user should coordinate with the vehicle dealer or servicing agency for the proper device(s) for each vehicle. The following information is furnished to assist in determining where RFI suppression devices may be required:

Diesel Vehicles -

1. Electrical charging system, e.g.; alternator, generator, regulator, etc..

2. Electric winches and motor driven accessories.

Gasoline(Benzene) Vehicles -

1. Ignition system, e.g.; Spark plugs, spark plug wiring, distributor, and coil.

2. Electrical charging system, e.g.; alternator, generator, regulator, etc..

3. Electric winches and motor driven accessories.

Mounted motor driven equipment -

1. Ignition system, e.g.; Spark plugs, spark plug wiring, distributor, and coil.

2. Electrical charging system, e.g.; alternator, generator, regulator, etc..

3. Electric winches and motor driven accessories.

APPENDIX 5

RADIO OPERATING PROCEDURES

The attached radio operating procedures provide a standard training guide for users of the Crop Protection Service HF Radio System. When additional frequencies and radios become available, certain small changes in the procedures will be necessary. Recommend that these pages be translated, reduced to 5 X 7 inch size, and laminated for durable ready reference by the operators.

MOBILE RADIO DAILY CHECKLIST

_____
DATE

	Y	N

1. Is the water level in the battery correct?

2. Are the power wires for the radio securely connected to the battery?

3. Are the battery terminals and connections free from corrosion?

4. Are the power wires and the antenna cable free of cuts, nicks, and abrasions?

5. Are all the radio components securely fastened to the vehicle?

6. Check the antenna and mount. Is there any damage?

7. Is there a tie-down for the antenna?

8. Turn on the radio. Does the power light come on?

9. Adjust the volume and squelch controls. Select the proper channel and sideband position. Do all the radio controls function correctly?

9. Inspect the microphone, cable and connector. Is it free of damage? Does the PTT switch work properly?

10. Is the radio turned off when not in use to prevent damage to the radio and battery?

_____
SIGNATURE

If any answer is no, have the radio checked by your supervisor or a radio technician.

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FIXED RADIO DAILY CHECKLIST

DATE

	Y	N

1. Is the water level in the battery correct?

2. Are the radio power and battery charger wires securely connected to the battery?

3. Are the battery terminals and connections free from corrosion?

4. Is the battery charger operating correctly?

5. Are the power wires and the antenna cable free of cuts, nicks, and abrasions?

6. Is the radio securely fastened at the operating position?

7. Check the antenna and antenna masts. Is there any damage?

8. Turn on the radio. Does the power light come on?

9. Adjust the volume and squelch controls. Select the proper channel and sideband position. Do all the radio controls function correctly?

9. Inspect the microphone, cable, and connector. Is it free of damage? Does the PTT switch work properly?

10. Is the radio turned off when not in use?

SIGNATURE

If any answer is no, have the radio checked by your supervisor or a radio technician.

NOTE: The battery charger must be plugged in and operating at all times except while servicing the battery or making electrical connections.

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GENERAL RADIO OPERATING PROCEDURES

1. All radio stations will maintain a station log. This log will contain as a minimum:

Date Time Station Called Channel or Frequency

2. Keep copies of written messages sent by your station for a period of one week. Annotate on the message the date and time transmitted.

3. Difficult or confusing words will be spelled out using the standard international phonetic alphabet.

4. Use standard procedural words (pro-words) when appropriate.

5. Use of preformatted messages to minimize confusion or misunderstanding and to speed the forwarding of information.

6. Use call signs to minimize confusion and properly identify stations transmitting.

7. Fixed stations will use their location as the call sign. An example is: "Thies this is Dakar, over".

8. Mobile stations will use the department they are operating in and a numerical identification. For example; "Thies this is Thies Mobile 2, over".

9. Transmissions should end with the word "Over" if you expect a reply or the word "Out" if no reply is expected.

PROCEDURAL WORDS

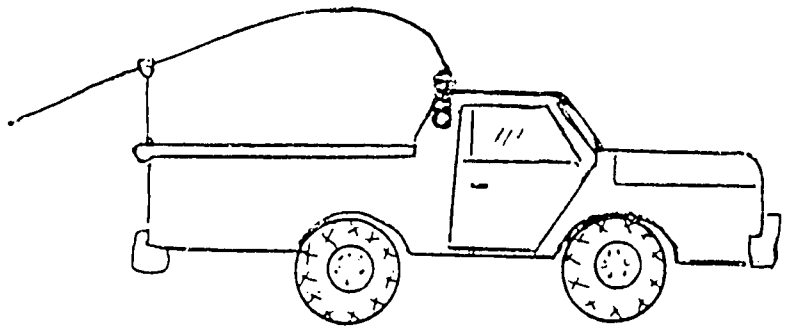
PRO-WORD	MEANING
Affirmative	Yes, or I agree with what you said
All After.....	Repeat all of your transmission after the word .....
All Before.....	Repeat all of your transmission before the word .....
Negative	No, or I do not agree with what you said
Out	I am finished, I do not expect a response
Over	I am finished, please respond
Roger	I received your transmission
Say again	Please repeat
Standby	I cannot transmit now but I will reply within one minute
Wait	I can not transmit now. I will call when able

INTERNATIONAL PHONETIC ALPHABET

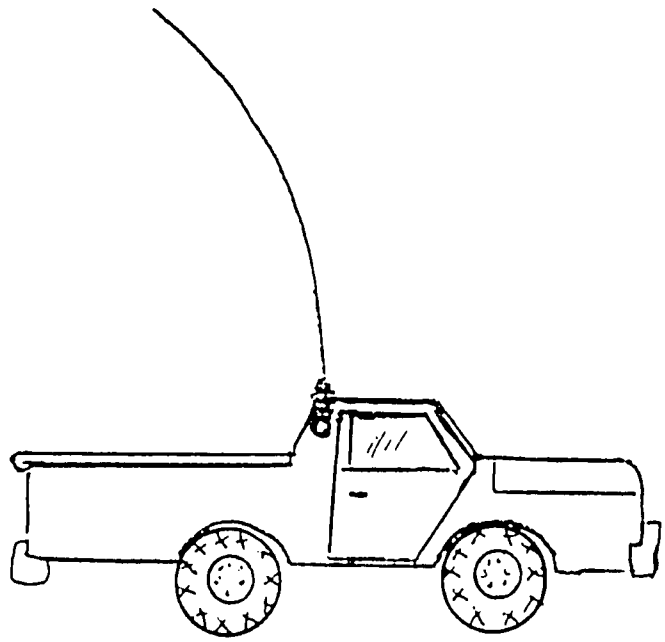
A	Alpha	N	November
B	Bravo	O	Oscar
C	Charlie	P	Papa
D	Delta	Q	Quebec
E	Echo	R	Romeo
F	Foxtrot	S	Sierra
G	Gulf	T	Tango
H	Hotel	U	Uniform
I	India	V	Victor
J	Juliet	W	Whiskey
K	Kilo	X	Xray
L	Lima	Y	Yankee
M	Mike	Z	Zulu

MOBILE ANTENNAS

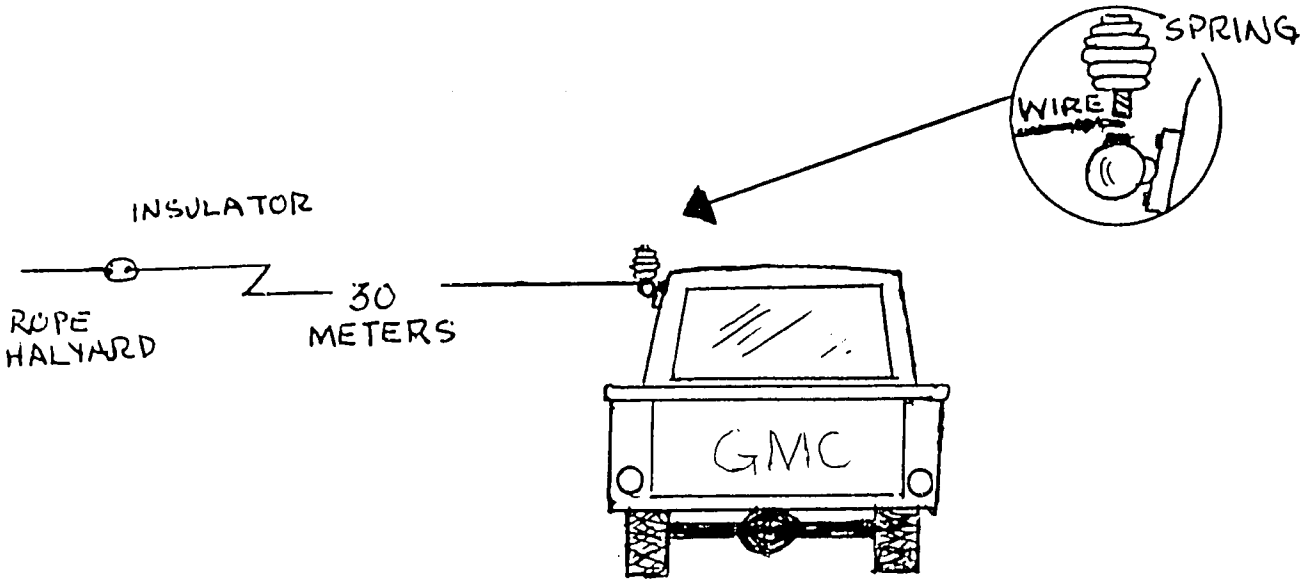
To increase the reliability of HF radio communications, mobile stations will sometimes need to change the antenna configuration.



Preferred configuration within 400 KM of the Base station



Preferred configuration over 400 KM to Base station



Expedient Antenna

If the whip antenna should break, you may use the above as a temporary antenna to maintain communications until the whip antenna is replaced.

APPENDIX 6

TECHNICAL ASSISTANCE
COMMUNICATIONS REQUIREMENTS

When technical assistance teams are established to conduct Desert Locust control operations maximum effectiveness is necessary due to the limited time available. Communications are essential to ensure the necessary effectiveness. Lack of adequate communications causes delays in obtaining support at the right places. With the Desert Locust, the time window is critical. Field survey information must be coordinated with treatment operations which must be coordinated with logistic support. Existing communications is minimal in many of the countries currently involved in the Desert Locust plague. Reliance on USAID mission communications is unwise. Mission communications generally are not adequate to cope with the wide area requirements of locust control operations. There is little in the way of equipment, technical skills, and communications knowledge available within the mission organization to support these operations. It is essential that adequate communications equipment, operational procedures, and communications expertise be provided to the technical assistance teams.

As the type and amount of assistance will vary by location, so must the communications required. Large aircraft operations are handled differently then small aircraft. Some countries have an effective CPS communications network, others do not. Defensive or protective treatment operations are conducted differently than preventative operations. All these factors have a bearing on the type and amount of communications required. There are however certain minimum requirements that must be satisfied at all times. Meeting these needs with existing in-country assets is preferable but few missions have this capability. The following paragraphs detail typical requirements for communications. Some of the assets described are available through other agencies, some will require purchase and storage between operations.

Land Mobile Communications:

An administrative/logistics support net is required to effectively control the use of vehicles, coordinate delivery of materials, ensure personnel availability, and a myriad of other daily needs. Currently a third of vehicle usage is in delivering messages and coordinating actions that could effectively be handled by radio. The average driver works fourteen to sixteen hours per day. This equals four to five hours of unnecessary use daily. For every two vehicles used eliminating the unnecessary travel and time would mean one additional vehicle available per day.

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A high frequency (HF) radio net is a multi-purpose requirement. Coordination between operating locations and the controlling office, communications with field survey/application monitoring teams, and communications with operations aircraft only outline the needs. Due to the topography of the countries involved in the locust operations and the lack of available communications HF radio is the only reliable system to meet the requirements for communications. An effective HF radio net requires not only equipment but the skills and knowledge to properly install and operate that equipment. Selection of appropriate antennas, installation of radios and antennas , and training personnel in radio operating procedures must also be accomplished. Making provisions for maintenance for equipment during long term operation must be considered.

Air/Ground Requirements:

This section is divided into two distinct areas involving aeronautical communications and navigation. While some recommendations are difficult to quantify in terms of dollar value of savings, their importance cannot be diminished. All recommendations made are to improve efficiency, increase safety, and enhance overall program effectiveness.

Communications:

The use of aircraft in large scale Desert Locust treatment programs is essential because of the large areas of infestation, the topography of the country involved, and the "window" of effectiveness for treatment during the life cycle of the Desert Locust. Timely communications with the aircraft is essential to relay information on changing meteorological conditions, alternate spray treatment areas, and aircraft emergency communications. With the limited range of VHF communications and the wide areas of operation, a high frequency (HF) radio system is necessary. During the current operations two separate incidents highlighted the need for communications to meet safety requirements. In the first instance, a pilot made a precautionary landing due to impaired visibility, remaining overnight at an alternate airport. When notified the aircraft failed to arrive and no way of determining the status of the aircraft, actions were begun to start a downed aircraft search. Information was finally relayed on the aircraft arrival just prior to host country notification. In the second incident, an engine failure required an emergency landing. Fortunately the pilot was able to land on a paved highway with no problem, and information was relayed within an hour that the plane was down and there were no injuries. In the first case an expensive search and rescue operation was barely averted, and in the second only the timing of the engine failure near a highway prevented a potentially serious accident with with no means of summoning assistance.

1. All aircraft involved in Desert Locust air operations,

survey, spotters, and applicators, must have operable HF radios installed. A HF flight following net will be operational whenever aircraft are airborne.

2. Survey and flagging personnel must be able to contact aircraft when meteorological or other conditions change impacting spraying operations. Handheld VHF AM radios with either magnetic mobile antennas or full length whip antennas meet this requirement adequately.

Aeronautical Radio-Navigation

Precise navigation within much of the country is severely restricted by the lack of existing navigational aids. With few identifiable terrain landmarks many flight hours are expended by "dead reckoning" navigation between airfields and spraying areas. During this operation, ten hours of of flight time was expended just in initially locating and identifying the airfield at R'Kiz. This was after the field had been marked with 3000 foot long white stripes. An estimated twenty minutes additional flight time was consumed on each flight between Nouakchott and R'Kiz by not flying direct routes. This totaled to over three additional flight hours. As the majority of spraying was done within a 30 mile radius of R'Kiz, it is difficult to estimate how much additional flight time was required in locating the spraying areas, ferry time between the airfield and the areas, and the accuracy of the spray blocks when flaggers were not used. With small aircraft thirteen hours of additional flying would purchase a portable non-directional beacon. As indicated by the cable information provided by USAID/Niger, the reduction of ferry times, and the increased accuracy of locating spray blocks significantly increases the effectiveness of the Desert Locust control programs.

1. All aircraft involved in Desert Locust control operations will have and operable LF/MF ADF (low frequency/medium frequency automatic direction finder) capability.

2. A portable LF/MF beacon must be installed at all remote operating airfields more than fifty nautical miles from fixed navigational aids when Omega systems are not used for navigation by the application aircraft.