

LAW ENFORCEMENT ASSISTANCE ADMINISTRATION (LEAA)

7 POLICE TECHNICAL ASSISTANCE REPORT

SUBJECT

Communications: Development of Radio  
Communications Bid Specifications *et*

*Window Rock (AZ)*

REPORT NUMBER

76-030-042

FOR

The Navajo Nation Police Department  
Window Rock, Arizona

Square Mile Area:

45,000

CONTRACTOR

Public Administration Service  
1776 Massachusetts Avenue Northwest  
Washington, D.C. 20036

CONSULTANT

R. James Evans

CONTRACT NUMBER

J-LEAA-002-76

DATE

April 21, 1976

34231

34521  
18543

FORWARD

Agency requesting assistance:

Navajo Nation Police Department.

General statement of problem area:

The immediate problem confronting the Navajo Police Department was the need of assistance in developing bid specifications for the procurement of communications equipment to be purchased through Grant # 75-DF-09-002. The need was created by the loss of Technical design personnel at the Navajo Nation Tribal Headquarters. It was apparent that the grant process would be delayed due to this problem.

Assistance had been requested from the State of Arizona Communications Division, but due to a heavy work load they were unable to assist the Nation.

Name of consultant performing the assignment:

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East Lansing, Michigan

Persons involved in request processing:

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P.D. Roland C. Dart III  
Superintendent of Police  
Navajo Police Department  
Window Rock, Arizona

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## I. INTRODUCTION

The Navajo Nation Police Department requires radio communications with its police vehicles throughout an area of approximately 150 by 300 miles. Much of this area is above 6800 feet and consists of some mountains and some farming area. There are approximately 120,000 persons living within the Nation.

The Police Department has five regional offices located in the more populated areas of the Nation. Each regional office will eventually have radio contact with its police cars on patrol or assignment. Additionally, future plans would provide a central dispatch office in Police Headquarters at Window Rock affording direct contact with all district offices and all police cars in the Nation.

The present Federal Grant provides basic improvements that are necessary to reach that goal.

The problem as stated by the applicant was to provide assistance in developing bid specifications for procurement of communications to be purchased through Grant 75-DF-09-0042. The technical requirements of this task were:

1. Personal contact with persons directly involved, Chief Dart and Mr. Price, Director of the communications division.
2. Review the overall system requirements, plans and maps of past, present and future communications needs.
3. Check out site locations for microwave and vhf stations (some by car, some by air).
4. Review of specifications already prepared and make suggestions and additions if necessary.
5. Prepare specifications for the purchase of microwave equipment.

The following personnel were contacted and interviewed during this assignment:

Roland C. Dart III  
Chief of Police

Mr. Eugene Price  
Director of Division of Support Services

Mr. Carroll Faris  
Navajo Communications Co.

Mr. Jerry Jacka  
SPA Phoenix, Arizona

Mr. Bob Hitchcock  
SPA Phoenix, Arizona

The above personnel all contributed some information to the project.

## II. UNDERSTANDING THE PROBLEM

In order to assist in the preparation of radio specifications and to arrive at the stated goal it was necessary to review the present radio system configuration, discuss the future communications design of the Navajo Nation and to look at possible alternatives in design, and then evaluate the material and information gathered.

Specific details of the problem to be reviewed include:

- the VHF mobile system.
- the existing microwave system.
- the NCIC contact.
- the telephone company system.
- the future radio system plan.
- the VHF mobile over entire Nation.
- VHF and future data.
- Teletype to NCIC through New Mexico or Arizona.
- Communications center at Police Headquarters at Window Rock.

The desire of Chief of Police, Roland Dart, is to have dependable radio communications with his police vehicles. The accomplishment of this objective is the responsibility of the Navajo Nation Communications Division. The purpose of the analysis is to assist the Nation in accomplishing that goal.

There appear to be at least three methods available for use in acquiring necessary radio equipment; all of which have already been given some consideration.

These are:

1. Rent point to point and mobile communications from the Navajo Communications Co. (Telephone). They have a fairly complete coverage of the Nation.

2. Navajo Nation provide the funds for the project.
3. Use Federal Assistance; LEAA to update and install the system.

The first method would require a rental fee for the entire life of the equipment. The fee would include installation and maintenance. Labor problems could develop with a private company that might cause out-of-service periods for the Police Department 24-hour service. This is something to be thoroughly considered.

The second method does not appear feasible due to the lack of money available at this time.

The third method is presently utilized, however, it will require continuous funding in the future to reach the goal.

The most serious problem facing the Navajo Nation Police Department is its lack of design and maintenance staff capability.

A copy of the specifications previously prepared by Navajo Nation was provided to the consultant for review and comments. These specifications were proposed for use in the purchase of Base Stations, Mobile Units, Towers and Emergency Power equipment.

### III. ANALYSIS OF THE PROBLEM

After a complete review of the existing communications and the future designs and plans of the Navajo Nation Police Department, the consultant was able to assist the Communications Division with the preparation of their specifications.

The VHF (150 to 160 MHz) mobile radio design that is planned is very adequate for the police department and should give them expansion capabilities for the next several years. The microwave design for future use is a point to point control system that carries information from cars and stations in distant areas back to headquarters. Both designs when implemented, appear to have the capacity to provide the desired communications for the Police Department.

During the analysis stage, it occurred to the consultant that a review of the local telephone company facilities should be considered since their system covers the entire Navajo Nation. Contact was made with Mr. Faris of the Navajo Communications company who advised that he could provide some of the communications needs, such as point to point facilities. The advantage of leased equipment is that maintenance is provided. The disadvantages are continued monthly costs and no guarantee of maintenance during labor problems. A cost comparison between leased and Nation owned facilities was not made, since this was not within the purview of this assignment.

The specifications for the towers, base stations, mobile units and the emergency power were reviewed during the analysis stage. The problems and requirements of the microwave system were also reviewed during this time. Mr. Hitchcock of the Arizona SPA stated that all required radio licenses must be obtained before any funds can be released and/or bids may be awarded. This regulation required that we look into the licensing requirements for each location. After considerable review, it was found that the

system required 13 additional licenses from the FCC. In an effort to expedite the license acquisition process, the consultant talked with the FCC microwave licensing section in Washington D.C. and with the FCC frequency coordinator in New Mexico.

It was determined that the licensing of the microwave equipment without the name and model of the equipment used, was not possible under the present rules. Therefore, Mr. Hitchcock (later in the project review) notified the Navajo Nation that the SPA would relax their restriction on only the microwave portion of the Grant. The VHF licenses will be coordinated as rapidly as possible through the Arizona and the New Mexico public safety coordinators and the FCC.

#### IV. FINDINGS AND CONCLUSIONS

Development of the microwave specifications was started by the consultant while on-site. This allowed an opportunity to gather exact information about power requirements, path clearance, size of antennas, etc. The specifications were completed during the week of April 5th, 1976. (A copy is attached as an appendix).

A review of the path clearance from Window Rock to Summit mountain was made by Mr. Price and the consultant. Mr. Price had reviewed this area as well as the path clearance from Navajo mountain to Preston Mesa and advises the paths are clear since there are existing systems now operating in these locations.

The licensing problem discussed in Section three is being expedited as rapidly as possible by Mr. Price and Chief Dart.

During discussions with Mr. Price, it was determined that the Nation lacked adequate radio design and maintenance staff capability. This problem, if not corrected in the near future, could cause delays in project implementation due to the lack of installation personnel. Also after project implementation there should be adequate equipment maintenance provided on a routine basis to ensure continuous and uninterrupted radio communications. Efforts are being made to acquire the necessary personnel at this time.

Chief Dart advised that he is trying to expedite a contract for leased installation and maintenance. If this materializes, the problem that now exists will be partially corrected. The need for a design engineer for communications will still exist.

It is the conclusion of the consultant that the police department should not consider leased service from the telephone company except in a service area not covered by the present system design, or in leasing facilities for contact with NCIC (National Crime Information Center).

## V. RECOMMENDATIONS

Since the problem was primarily one of assistance in specifications, there are not many practical solutions offered here. Those recommendations felt to be noteworthy are listed below.

### 1. General Recommendations

Resolve the problems of bidding and procurement of equipment; of licensing station locations, and of hiring installation and maintenance personnel as rapidly as possible.

### 2. Specific Recommendations

- a. It is recommended that there be early consideration and funding of a central dispatch center at the Police Headquarters at Window Rock. This will enhance system, vehicle, and manpower coordination.
- b. Assign a project coordinator to keep abreast of and expedite the bids, purchase, installation and final testing and approval of the system. This is now being taken care of by Mr. Price who is burdened by many other important tasks.
- c. It is recommended that immediate consideration be given to hiring qualified design, installation and maintenance personnel.
- d. It is recommended that there be immediate processing of a lease agreement for installation and maintenance.
- e. The consultant recommends that the base equipment, microwave equipment and antennas, towers and emergency power be purchased on a "turn-key" basis. This would assure a radio installation that had vendor warranty and would help speed up the installations. This would not be necessary if either c. or d. results.
- f. The licensing of the 13 station locations should be pursued as rapidly as possible; perhaps by hand carrying the applications to the various coordinating committees and directly to the FCC in Washington, D.C.

- g. The equipment specifications that appear as an appendix to this report should be adopted for use in the procurement of the radio and microwave equipment contemplated.

NAVAJO NATION

Communications Department

Specifications  
for  
Microwave R.F.

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1.0 GENERAL

The following specifications describe radio equipment in the microwave region of the spectrum, specifically designed for the 2 GHz. band.

The intent of the specifications is to provide a modern, up-to-date point-to-point communications system with expandable capabilities to meet the needs of the Navajo Nation both now and in the future.

The specifications do not include any proprietary items, components, circuits or devices which would preclude any communications equipment manufacturer from producing equipment to meet these specifications.

All technical tolerances, ratings, power outputs, or any technically specified criteria contained within these specifications are considered to be within the current state of the electronic art and are currently being met by commercially available equipment. The fact that a manufacturer chooses not to produce equipment to meet these specifications is not sufficient cause to adjudge these specifications restrictive.

Path clearance has been established and is not a responsibility of the vendor on this specification.

2.0 ELECTRICAL

The primary power for the microwave R.F. equipment will be 24 volts D.C. This power will be supplied from batteries that will be described on a separate specification.

The primary power for all other accessories will be 117 volts A.C., 60 Hz., single phase. The accessories are items such as, tower lights, radome heaters, building lights and etc.

The equipment power supplies for the R.F. radio shall have short circuit protection and reverse battery protection.

3.0 OPERATING FREQUENCIES

This specification defines microwave transmitting and receiving equipment to be operated in the Public-Safety radio band between 1.7 and 2.3 GHz. The exact frequencies for four tower sites are being selected at this time and will be applied for prior to bid approval. The exact frequencies will be stipulated on the purchase order.

#### 4.0 STANDARDS AND DESIGN

The transmitters, receivers, baseband, standby R.F., antennas, coaxial cable and all associated items shall meet or exceed the current E.I.A., F.C.C., I.E.E.E. standards and the revised regulations in part 94 of the F.C.C. rules.

Where requirements of the Navajo Nation are more stringent than those listed above, the Navajo Nation's specifications shall apply.

The equipment shall be designed for continuous duty service and shall be constructed of all solid state components. The equipment shall be consistent with the latest design techniques and present state-of-the-art in the industry.

The radio frequency equipment, baseband, and power supplies shall be designed in shelf style with circuitry mounted on plug-in cards or modules that are removable from the front of the rack.

The card or module base material shall be of high quality to minimize circuit failures.

All racks and cabinets shall be designed to accept a standard 19 inch panel.

All active circuits, fuses, controls and test points shall be accessible from the front of the cabinet.

The main equipment and standby shall operate from one antenna.

#### 5.0 TRANSMITTERS/RECEIVERS, R.F.

The transmitter/receiver rack shall be constructed with sufficient vertical capacity to contain the main transmitter/receiver, the protected (hot-standby) unit, the baseband, the r.f. combiner or coupler, any necessary filters or duplexers, all interface equipment, the alarm outputs, the power supplies, the metering equipment and any other necessary items or circuits.

All tuning adjustments necessary in the r.f. equipment, except the combiners and duplexers/filters, shall be made from the front of the cabinet. A tuning meter with switching facilities shall be mounted on the front of the radio for maintenance purposes.

The baseband chassis shall provide alarm circuits to indicate loss of r.f. (the circuit will indicate a loss of 3 dB. or more in power), loss of pilot continuity, or loss of a.f.c. These alarm circuits shall have visual indicators in addition to output contacts to actuate external alarm transmitters.

All power supplies in the r.f. and baseband section of the equipment shall be regulated.

The baseband of the radio equipment shall be arranged to provide two separate basebands designated as a supervisory baseband and a message baseband. Baseband splitting filters shall be used to isolate the supervisory and message bands. The message baseband input circuits shall be designed to operate with per-channel input level of -45 dBm. The message baseband output level for rated deviation of the transmitter shall be at least -14 dBm. An output level control shall be provided on the receiver to accurately provide this adjustment.

The message baseband input and output impedance shall be 75 ohms unbalanced or 130 ohms balanced.

The level of stability of the message baseband shall be such that, with an unvarying input level to a transmitter, the level at the output of a distant receiver will not vary more than 0.5 dB over a 30 day period.

The supervisory baseband input and output impedances shall be 600 ohms balanced.

The supervisory baseband input level per channel

shall be -45 dBm minimum. The output level shall be at least -10 dBm per channel.

An order wire facility shall be provided and shall have provision for a voice frequency circuit, tone calling, and tone signaling circuits to operate over the supervisory baseband of the radio.

The input and output levels of the line side of the orderwire shall be adjustable to match the baseband levels of the microwave equipment.

The order wire facility shall have a tone signaling and a tone calling circuit that will operate below 3.0 kHz. The tone transmitter shall include a switch or pushbutton to initiate the tone. At the receive end of the circuit the tone receiver will operate a call lamp or audible alarm. A remote two-wire extension phone and speaker shall be installed at each microwave location.

A radio pilot signal shall be provided for continuous operation in all microwave equipment, the tone will be inserted on the baseband before the first active unit and detected after the last active unit in each transmitter.

Failure of the circuitry in either the main or the standby receiver that causes the loss of the baseband output shall activate the pilot alarm and cause the receiver combiner to mute the output of the defective unit and continue service on the opposite unit at no change in the baseband received level. The alarm information will operate an alarm indicator and also a relay which will provide dry contacts for the external alarm system. The pilot frequency can either be above or below the usable baseband frequency range.

The microwave technical specifications are as follows:

TRANSMITTER

R.F. Band-----1.7 to 2.3 GHz.  
Modulation-----FM  
Frequency stability-----0.001% Min.  
Ambient temperature----- -10 to +50 degrees C.  
Operating altitude-----15,000 feet ASL  
R.F power output-----36 dBm or more  
Output impedance-----50 ohms.  
Spurious emission----- -70 dB or better.  
Power source----- -24 volts d.c.  
Design----- Solid state

RECEIVER

R.F. band-----1.7 to 2.3 GHz.  
Modulation-----FM  
Frequency stability-----0.001% Min.  
Ambient temperature----- -10 to +50 degrees C.  
Operating altitude-----15,000 feet ASL  
Input impedance-----50 ohms  
Spurious response----- -65 dB or better  
Power source----- -24 volts d.c.

BASEBAND

Impedance-----75 ohms unbalanced  
Baseband switching-----3 us (less sensing time)  
Sensing time-----60 milliseconds maxium

6.0 HOT STANDBY EQUIPMENT

The microwave terminal shall be supplied with a protected type of equipment configuration. The term hot standby shall imply that the microwave terminal will consist of two radio transmitters, two receivers, two power supplies and the antenna configuration for switching and sensing in addition to the control circuitry. During normal operation both transmitters and receivers will be energized by their power units. The modulating signal shall be applied to both transmitters simultaneously. A decrease in the r.f. power by 3 dB or the loss of the transmitter pilot

on the on-line transmitter shall initiate a switch to the alternate transmitter and actuate the appropriate alarm function. Manual re-setting of the equipment shall not be required. A visual means shall indicate which transmitter/receiver is in service.. (alarm transmitters will be purchased on a separate specification for remote supervision of failures). A means shall be provided to manually switch between the two r.f. systems. An r.f. switch will be used to connect either transmitter/receiver combination to the duplexer transmit/receive port of the opposite unit. Switching time for this action shall not exceed three microseconds. The alarm sensing shall not exceed sixty milliseconds. The r.f. antenna switch shall have a minimum of 70 dB isolation between the main unit port and the standby port.

#### 7.0 EQUIPMENT TEST FACILITIES

The microwave r.f. equipment as described in these specifications will be provided with adequate test points to measure the input and output of all active circuits. A test meter and selector switch will measure as a minimum, the antenna power, the reflected power, the transmitter output power and the receiver a.g.c. An external position on the selector switch will allow the measurement of major

circuits throughout the microwave equipment. All test points and proper and or average current, voltage and resistance measurements shall be included in the maintenance manual.

#### 8.0 ANTENNAS

This specification will include a minimum of four eight foot parabolic antennas. These antennas will have an average gain of 31.5 dB with vertical polarization. If additional antennas are required in the system, it will be so stated on the bid document. Mounting hardware shall be determined at the time of the radio tower bids are received, however the mounting hardware is to be considered a necessary part of the antenna bid.

The antennas must comply with previous stated standards of EIA and FCC.

#### COAXIAL CABLE

The vendor shall supply a low loss foam dielectric 7/8 inch coaxial cable. The exact length will be advised at the time of the bid request. Cable fittings to the antennas and the r.f. equipment will be supplied. Cable connectors for the tower will be purchased at the time of the tower bid award. The vendor shall bid an option on air dielectric 7/8 inch cable that may be pressurized.

RADOMES

A standard eight foot non-heated radome shall be bid. An optional bid shall be made on an eight foot heated radome. With the optional bid the vendor shall supply the amount of loss in dB's with the heated radome and the VSWR with the radome installed and the equipment operating.

PRESSURE SYSTEMS

A pressure system will not be required if foam dielectric cable is purchased, however an optional bid is requested on a pressure system for two locations with several coaxial lines in order to determine if there would be additional system improvement.

9.0 WORKMANSHIP

The equipment supplied under this specification shall be of the latest, most improved model, past the development stage and in factory production with a satisfactory record.

10.0 GUARANTEE

All equipment described in this specification shall be fully guaranteed by the vendor against mechanical and electrical defects for a period of 12 months from

the date of installation, or component manufacturer's warranty, whichever is greater. Any defects of design, workmanship, or material shall be fully corrected by the vendor without cost to the purchaser. The equipment shall be warranted to meet, at the time of installation all requirements of this specification for normal conditions of installation and adjustment. Equipment requiring warranty work will be presented to the manufacturer's nearest service facility for repairs.

11.0 DATA TO BE SUBMITTED

At the time of submitting his bid, each bidder must submit complete technical information, graphs, photographs, circuit diagrams, instruction manuals, or other means to fully describe his equipment.

In the event the published literature furnished by the bidder is at variance with the minimum requirements of any items in this specification, the bidder shall explain in detail, with full engineering support data, the reasons why the bidder's proposed equipment will meet the Navajo Nation's requirements and should not be considered an exception to the specifications.

Failure to supply complete technical information will be sufficient cause for rejection of the bid.

## 12.0 INSTRUCTION MANUALS

The instructions books to be furnished by the vendor, shall be complete with all pages securely fastened together. The instruction books shall incorporate, as a minimum, the following information:

- a. Table of contents
- b. Complete description and ordering information of each individual unit and/or sub-assembly and electrical component, which is a part of the whole equipment assembly.
- c. Complete inter-cabling diagram between each unit and/or sub-assembly.
- d. Complete outline and mounting dimensions of equipment.
- e. Voltage and resistance diagrams or tables of all units and/or sub-assemblies.
- f. Complete tuning instructions in step-by-step tabular form for entire assembly and all components capable of being adjusted.
- g. Parts location, drawings, pictorial details and top view of individual parts and/or sub-assemblies.
- h. Operational block diagram of individual units and/or sub-assemblies.

One instruction manual shall be furnished for all equipment supplied under this specification.

## 13.0 PRICING

No conditional quotations will be acceptable. All pricing shall be fixed, and include all applicable taxes, freight, insurance, etc.

14.0 MAINTENANCE TRAINING CLASSES

The vendor shall conduct a training class on the operation and maintenance of all equipment. The classes shall be conducted at the Navajo Nation Communications Department, Fort Defiance, AZ. The classes shall be held in the Communications conference room. The instructor shall be intimately familiar with the operation and maintenance of all equipment. The class shall be at least two days in length, with a minimum of 6 hours instruction per day. Actual dates for these classes shall be established by the Communications Director..

15.0 PARTS

The bidder shall maintain a stock of replacement parts for each item included in this equipment, and shall guarantee to make available such parts for a period consistent with the life of the equipment, while the equipment is in service, or for ten years, whichever is greater. Exchange parts or boards shall have a turn-around time of no more than three working days.

16.0 DELIVERY

All vendors must quote a delivery date. Preference will be given during bid evaluation to the earliest possible delivery date.

All equipment supplied under this specification shall  
be delivered FOB to:

Communications Department  
Post Office Box "D"  
Fort Defiance, AZ.

not later than 90 days after receipt of the Navajo  
Nation's Purchase Order.

Bids on equipment will be addressed to:

THE NAVAJO NATION  
Purchasing Department  
Window Rock, AZ. 86515