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NOSC Wideband VHF Whip Antenna

DM Dilley

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This document presents an account of the development of a wideband vhf whip antenna 6 feet long and having a base mount compatible with AS-1729 antennas. Integrated compensation in the antenna radiating element provides a 3:1 or better standing wave ratio over most of the 30-76 MHz band. A dozen prototype antennas were delivered for field testing. In preliminary field tests, the performance of the new vhf antenna equaled or exceeded that of the AS-1729 and RC-292 antennas. Tests are continuing at Camp Pendleton, CA.

OBJECTIVE

The purpose of NSAP project Q-2-78 was to carry forward development of the NOSC designed wideband vhf whip antenna that resulted in a prototype suitable for field tests.

RESULTS

1. One dozen prototypes of the NOSC wideband vhf whip antenna were produced. NOSC provided electrical and mechanical fabrication and final assembly. Conolon Corp, Santa Ana, California, provided fiberglass fabrication.

2. Nine prototype antennas were delivered to Camp Pendleton for field tests. Preliminary tests have been made comparing the NOSC antenna to the vehicle-mounted AS-1729 and the mast mounted RC-292.

3. In these preliminary field tests, the operational performance of the NOSC antenna equaled or exceeded that of the AS-1729 and the RC-292.

4. Additional field tests are in progress at Camp Pendleton to evaluate the NOSC antenna mounted on an LVTC-7 command tractor.

5. Two patent disclosures have been filed on the NOSC Wideband VHF Whip Antenna: NC63, 121, DM Dilley, NOSC and NC63, 398, DB Forman, NOSC.

RECOMMENDATIONS

1. Continue field tests of the NOSC wideband vhf antenna at Camp Pendleton to evaluate its suitability for application on amphibious and armored vehicles.

2. Extend field tests to include the Navy's fast patrol craft.

3. Establish a method of reporting the progress of field tests to NOSC designers.

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INTRODUCTION

This report presents an account of the development of the NOSC wideband vhf whip antenna sponsored under NSAP project Q-2-78. Included are a functional description of the antenna, a narrative of its development, the results of several tests including field tests, and recommendations for ongoing development.

BACKGROUND

The US Navy and Marine Corps operate single and multiple-channel vhf communication systems in the 30 through 76 MHz band. These systems are installed on ships of the Fleet and fast patrol craft, and are used extensively in field communications ashore, both portable and mobile. Vhf communications are used by the Marine Corps during amphibious operations.

The US Navy and Marine Corps have a requirement for a new low cost, lightweight replacement vhf (30 through 76 MHz) broadband antenna. The primary candidates for replacement are the vehicular AS-1729 and the mast mounted RC-292. The purpose for the RC-292 replacement is to obviate the need to rerig the antenna every time a significant frequency change is made, and reduce the weight of the antenna to facilitate erection. The purpose of the vehicular AS-1729 antenna replacement is to obtain a low profile (the AS-1729 is a 10 foot whip) and to improve reliability by replacing an electromechanically tuned antenna with an untuned antenna.

In USMC field applications with the LVTC-7 command tractor, the large number of closely spaced whip antennas seriously disturbs the omni-directional radiation characteristics of any one of the whip antennas. Used with a suitable rf summing network, the replacement wideband antenna could be used with several transmitters simultaneously.

Several antennas under development are being considered as replacements for the AS-1729 and RC-292. In production quantities, they are expected to cost in the range of $100 to $300.

Preliminary tests performed on an NOSC designed wideband vhf whip antenna in November 1977 indicated that the antenna could satisfy the replacement functional requirements at a cost of $30 to $60 in production quantities.

DESCRIPTION

The NOSC Wideband VHF Antenna is a 71 inch fiberglass whip with a 5.5 inch mounting base compatible with mounts now used for AS-1729 antennas. The antenna uses integrated compensation in the radiating element to achieve a 3:1 or better standing wave ratio over most of the band 30 through 76 MHz without auxiliary electromechanical tuners or lumped-constant reactances in the base. The feedpoint impedance of the antenna is nominally 50 ohms via a BNC type coaxial connector at the base mounting plate. The prototype antennas are designed for a maximum input power of 75 watts.

THEORY OF OPERATION

Electrically the antenna consists of a 4:1 wideband impedance transformer and a double stub compensated radiating element. A schematic diagram of the antenna is shown in figure 1. The short stub formed by the small loop effectively lengthens the antenna on lower frequencies and divorces the lower section of the antenna at the higher frequencies. The long stub formed on the main loop broadens the frequency response at the middle frequencies.

WHIP AND BASE CONSTRUCTION

The fiberglass whip section consists of a tapered core, an inlaid braided conductor, and an outer jacket of fiberglass. The core material used is single off-center ground extruded fiberglass. Three equispaced 1/16 inch X 1/16 inch slots are broached into the core to receive the braided conductor. To form the jacket, an outer layer of impregnated fiberglass cloth is wrapped around the assembled radiator. The assembled whip section is then cured and given a weatherproof coating of epoxy paint. A cut-away view of the whip section is shown in figure 2.

The antenna base consists of a mounting fixture of 6061-T6 aluminum, a BNC connector, and a 4:1 torroidal wideband impedance transformer. The base is assembled to the whip section using polyurethane potting material.

EVOLUTION OF THE COMPENSATED RADIATOR

The motive for the initial design effort was to develop a low cost, low profile, wideband vehicular vhf antenna for the frequency range 30-76 MHz. Approaches taken in the design included multiple trap, tapered helical wrap, coaxial stub compensation, terminated traveling wave, and integrated open line compensation.

TRAVELING WAVE APPROACH

The multiple trap approach led to Q problems. The tapered helical wrap gave only moderate bandwidth Coaxial stub compensation required more space in the base structure than could be allowed.

The traveling wave approach, however, satisfied bandwidth and dimensional constraints at the price of a dissipative element in the base structure. It allowed the bandwidth requirements to be met by a vertical element 5.5 feet high with a 0.25 inch mean diameter. The antenna consisted of a conducting loop bonded to a fiberglass rod, a wideband input transformer, and a resistive termination. The theory of operation for the traveling wave or squashed rhombic antenna is handled extensively in the literature and will not be repeated here.

TESTS ON TRAVELING WAVE ANTENNA

Preliminary tests performed at NOSC showed that the traveling wave antenna provided a VSWR of 3:1 over most of the frequency range 30-76 MHz. The results of these tests showed the antenna to have sufficient merit for further development.

TESTS USING JEEP

In December 1977, the 1st Marine Division at Camp Pendleton loaned to NOSC a USMC jeep configured as a 110 communications vehicle. Installed on the jeep were two RT-524 transceivers and two AS-1729 whip antennas. A fixed receive site was set up with

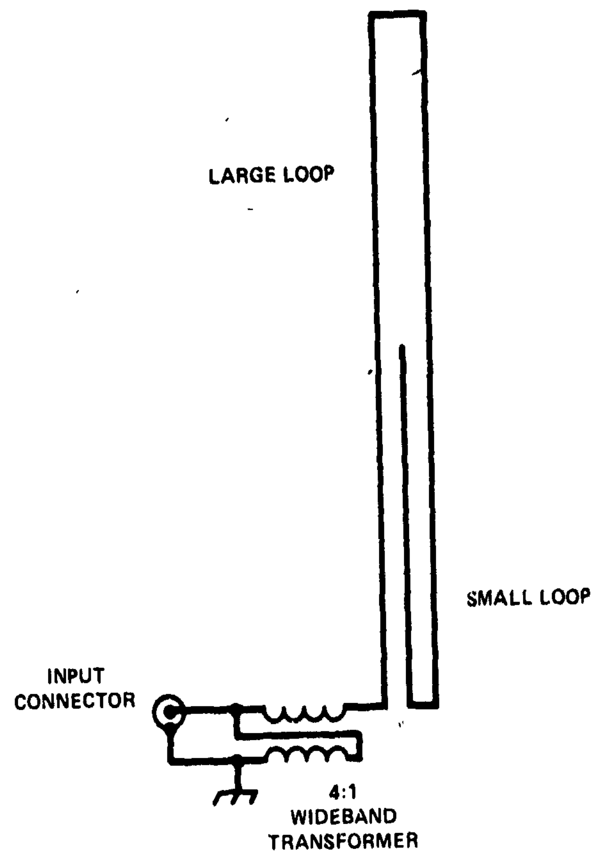


Figure 1. Electrical schematic of the NOSC vhf antena.

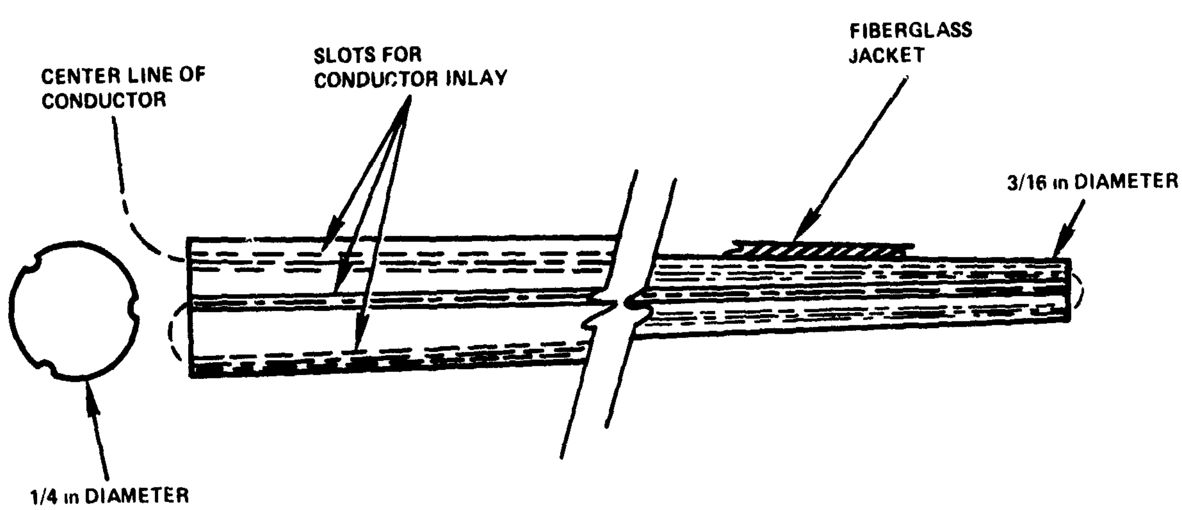


Figure 2. Construction of fiberglass whip.

a short monopole mounted on a van in a parking lot. One of the AS-1729 antennas was removed from the jeep and the traveling wave antenna mounted in its place. The test setup was as shown in figure 3.

The jeep was located about 100 feet from the receive antenna and the antennas were compared for radiating efficiency at 2 MHz intervals from 30-63 MHz, (frequency range limited by test receiver). Relative signal strengths were measured by establishing a reference level on the receiver's signal strength meter and noting the required attenuation change as the antennas and frequencies were changed. The resulting signal strength comparison is shown in figure 4.

To account for differences in the RT-524 transceivers, the antennas were switched and the signal strength measurements repeated. The results of this test are shown in figure 5; note that the largest variation between transceivers is at lower frequencies.

The standing wave ratios of the two antennas were compared by measuring forward and reflected power. These results as a function of frequency are shown in figure 6.

TESTS AT 0.5 MILE RANGE

The jeep was located at about 0.5 mile from the receive antenna, beside a road with a steep bank about 5 yards on the far side. The jeep was visible from the receive antenna. The relative signal strengths in the frequency range 30-63 MHz are shown in figure 7. The anomalies at 49 MHz and 59 MHz suggested that the signal strength was a function of the jeep's orientation with respect to the receive site and surrounding terrain.

With the jeep at the same location, the signal strength from both antennas at 59 MHz was measured for four vehicle orientations approximately 90 degrees apart. These measurements are shown in figure 8.

The antenna installation for the tests is shown in figure 9. The relative mechanical flexibility of the two antennas is shown in figure 10.

NSAP PROJECT Q-2-78

The results of preliminary testing on the traveling wave whip antenna were brought to the attention of the NOSC Marine Corps Liaison Office and the NOSC Fleet Readiness Office. In March of 1978 an NSAP project was established at the request of the Communications Electronics Officer (CEO), 1st Marine Division, Camp Pendleton. Specific objectives of the development project were:

a. Optimize radiator for frequency range 30-76 MHz.

b. Optimize termination.

c. Determine suitable integration of conductor with fiberglass rod.

d. Provide suitable base mounting fixtures.

e. Verify power handling capability of 60 W.

f. Perform environmental tests to establish confidence in the ability of the antenna to withstand field testing.

g. Perform relevant field tests at Camp Pendleton.

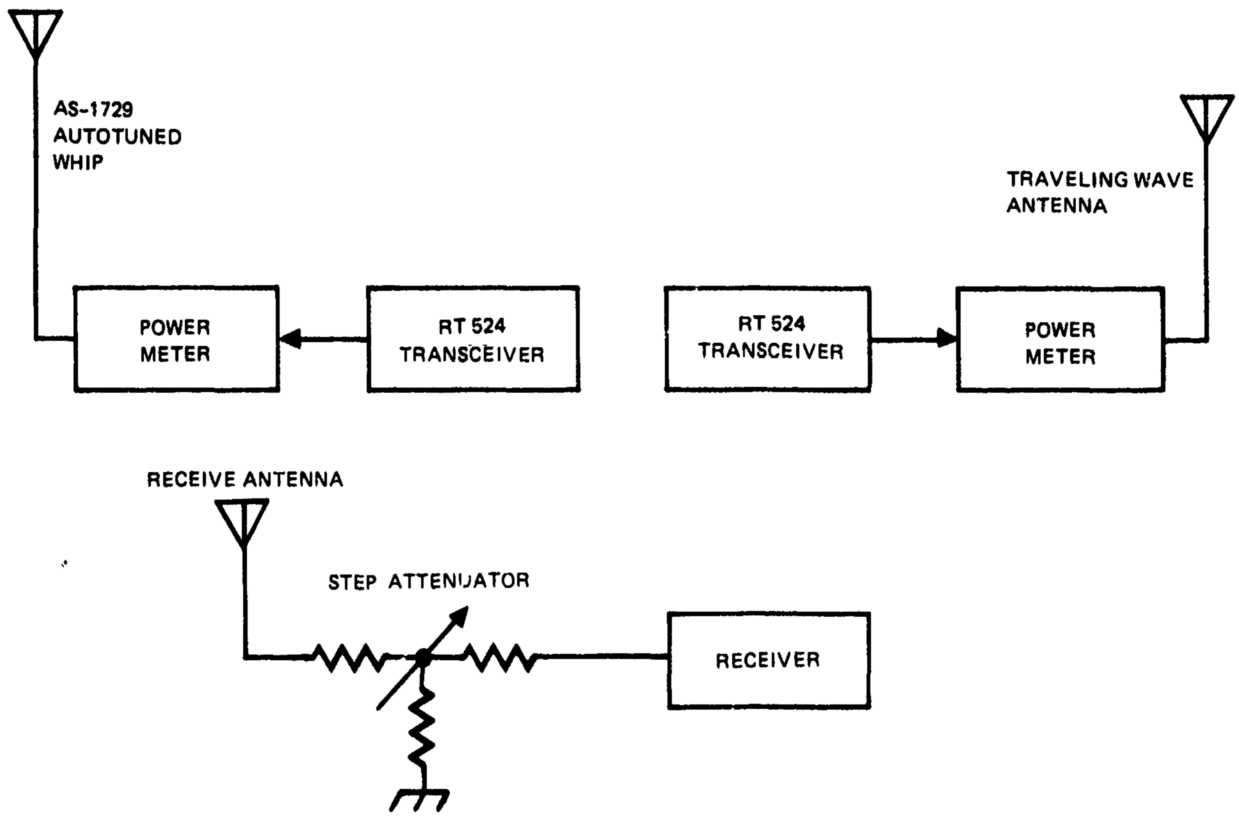


Figure 3. Test setup A.

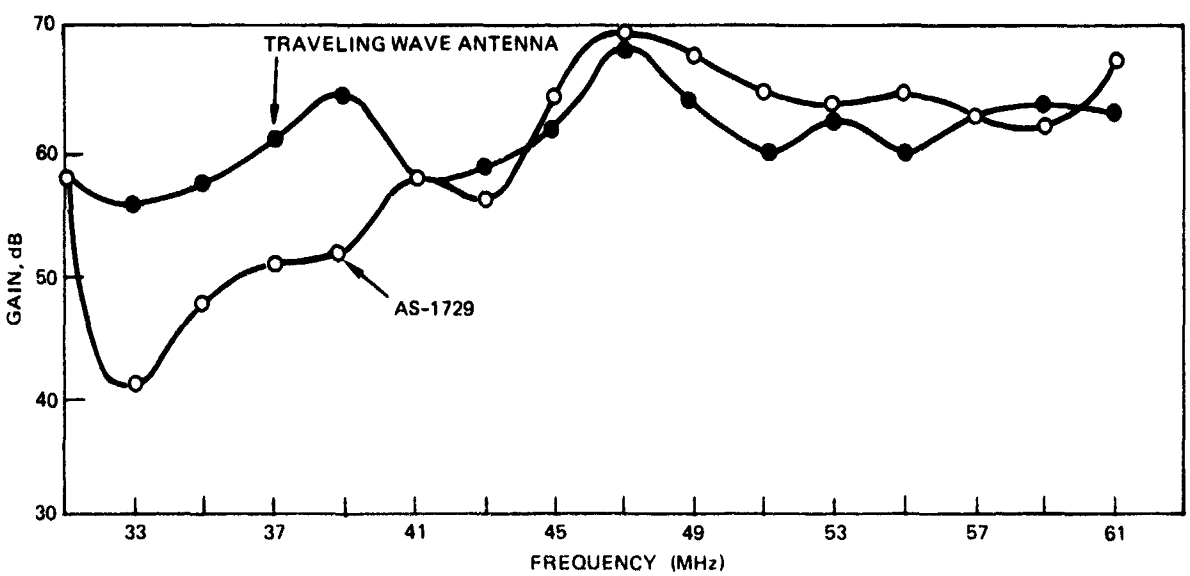


Figure 4. Jeep in parking lot approximately 100 feet from the receive antenna.

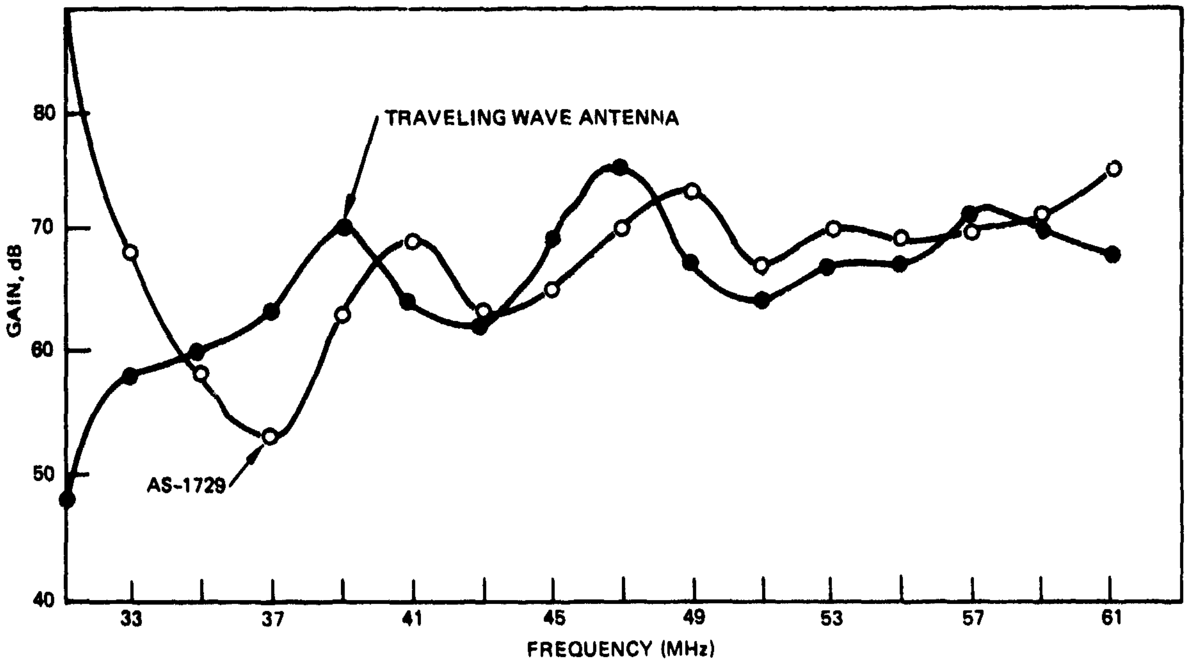


Figure 5. Jeep in parking lot approximately 100 feet from the receive antenna with transmitters switched from the configuration of figure 4.

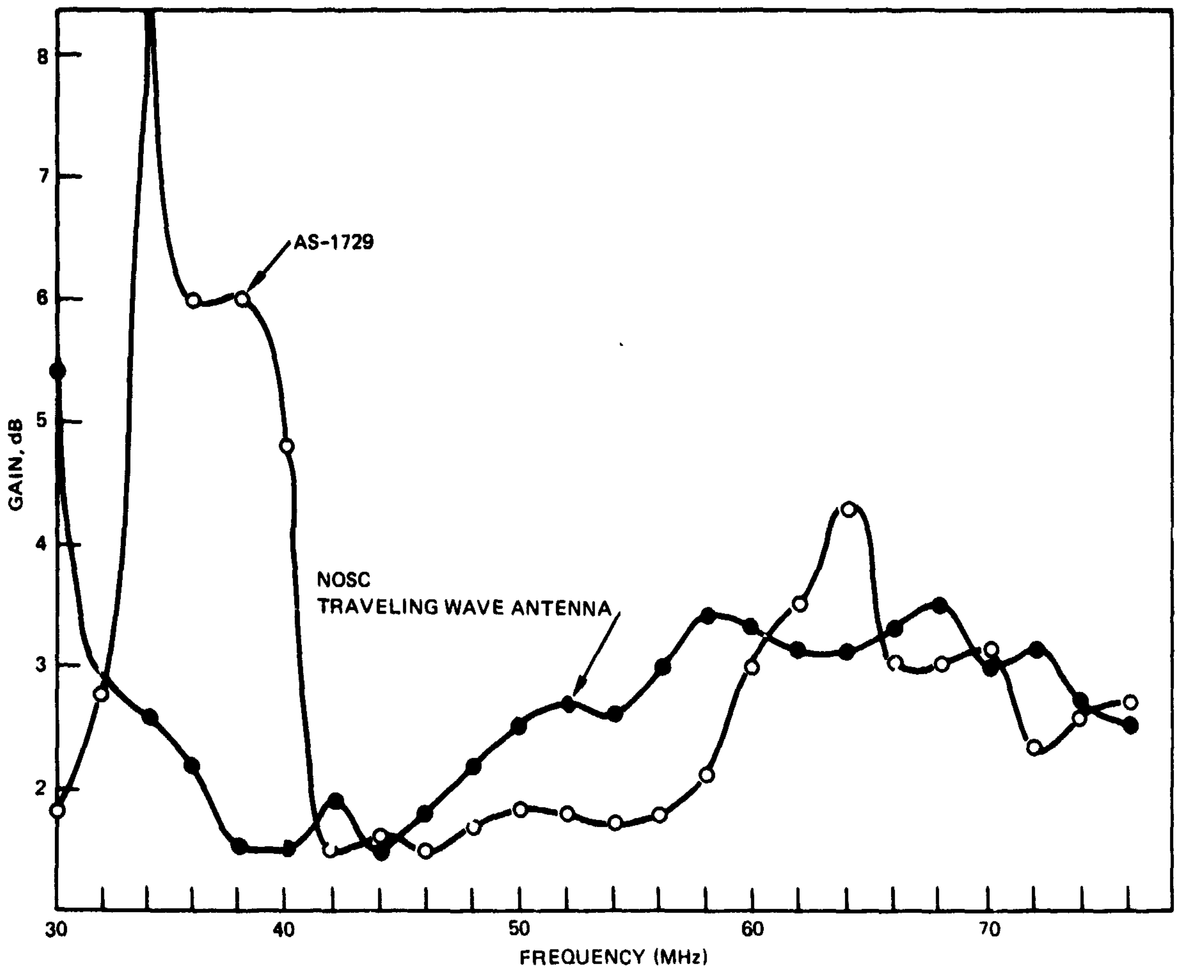


Figure 6. VSWR for both the AS-1729 antenna and the traveling wave antenna over the vhf band.

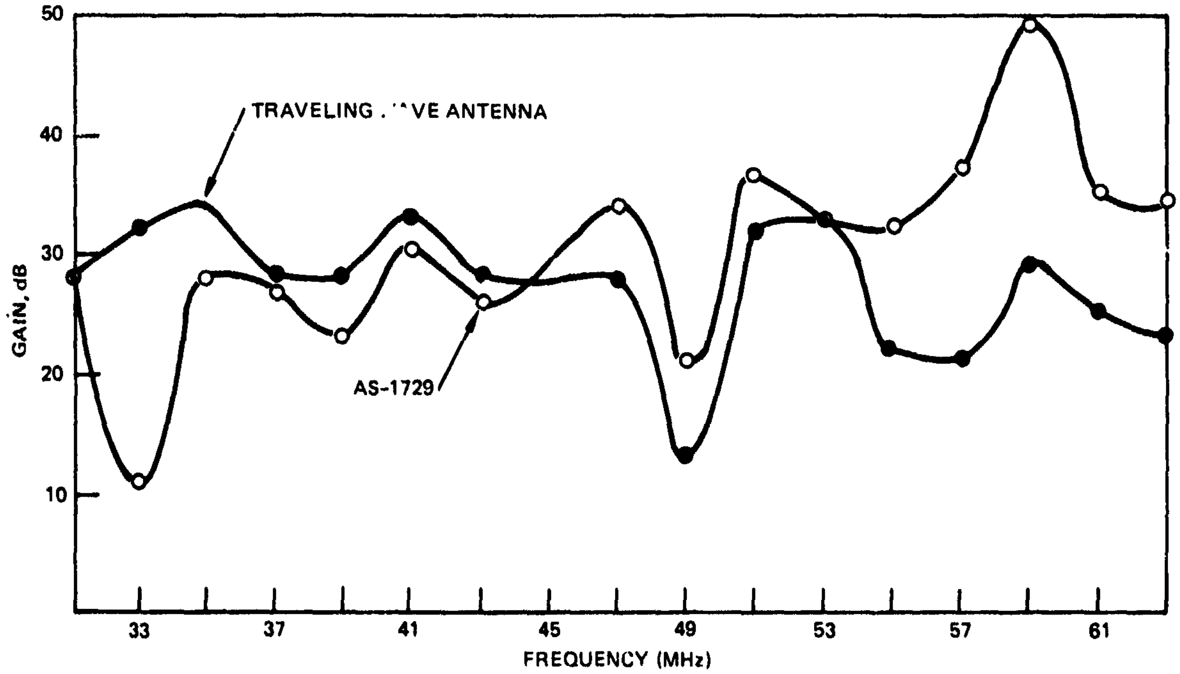


Figure 7. Relative signal strength at a distance of approximately 0.5 mile.

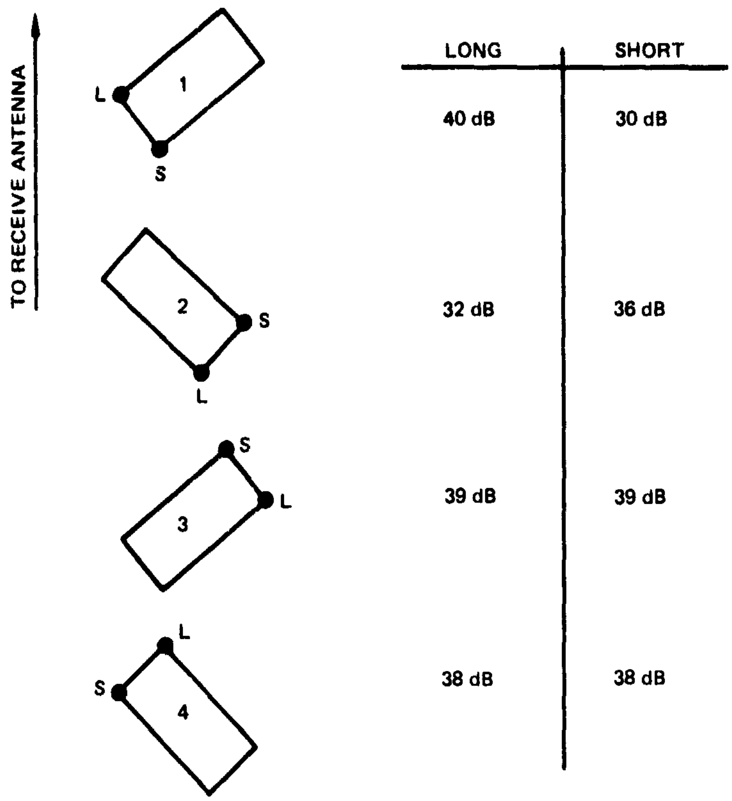


Figure 8. Relative signal strength at 59.3 MHz as a function of vehicle orientation with respect to the receive antenna.

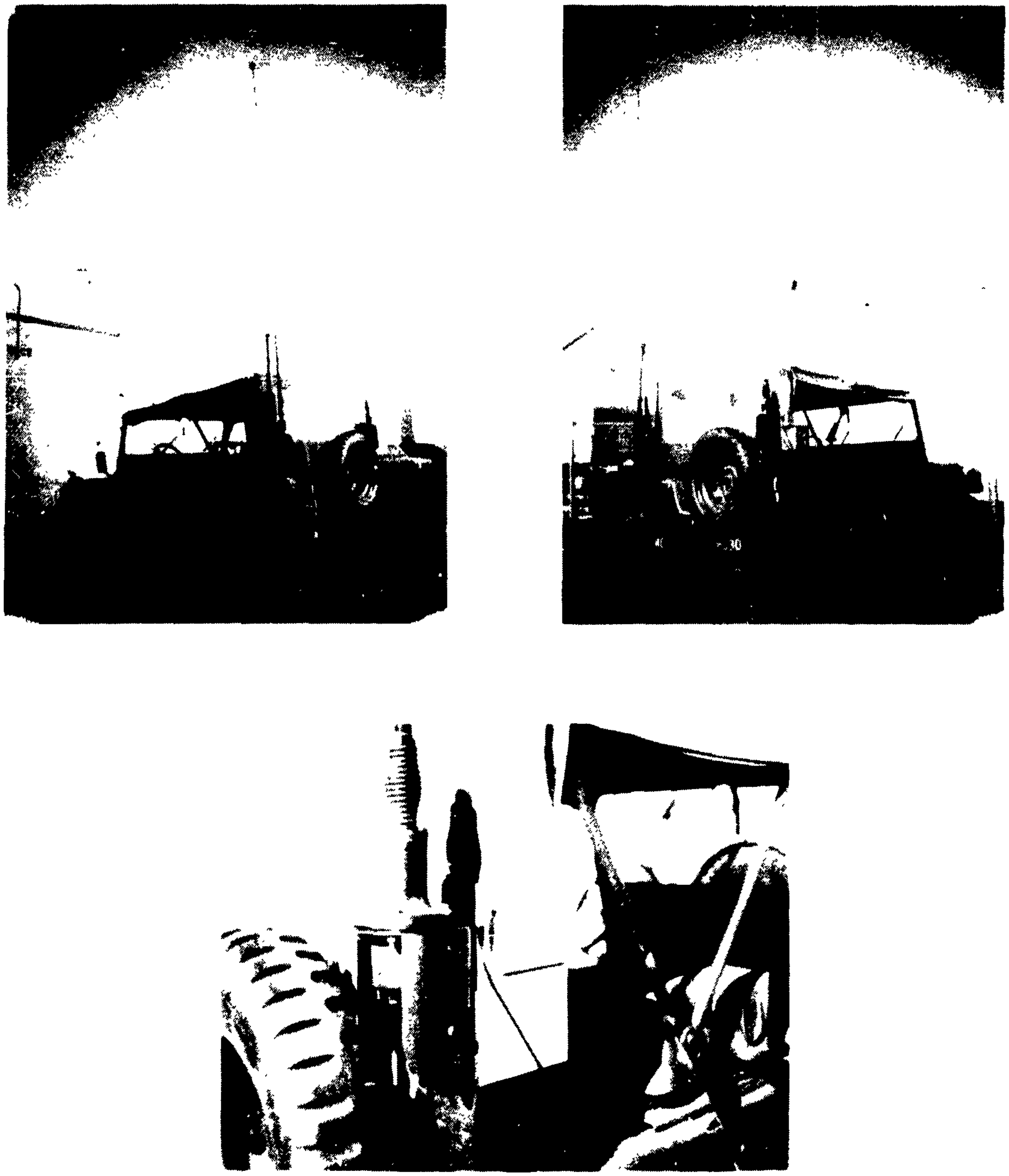


Figure 9. Three views of the test antenna installed on the jeep.

a. AS-1729 WHIP

b. NOSC VHF WHIP ANTENNA

Figure 10. Antenna flexibility.

ANTENNA WITH INTEGRATED OPEN LINE COMPENSATION

Although the terminated traveling wave antenna had acceptable VSWR and efficiency in the frequency range of 30 to 76 MHz, it was thought that a reflective termination might offer several advantages. Efficiency could be increased by removing the lossy element, the base size and weight would be less for a given power handling capability, and the cost of the reactive element would be less than the resistive termination.

The reflective element used was a compensating stub integrated into the radiating element. The stub was resonant at approximately 70 MHz and served to effectively shorten the radiator at the higher frequencies while restricting radiation to the upper portion of the whip.

TESTS ON THE COMPENSATED RADIATOR

In April 1978, testing began on the latest evolution of the wideband antenna. The antenna was compared with a 12 foot vehicle whip produced by Marconi. The comparison was for radiating efficiency and was performed at a range of about 3/4 mile. The test setup was as shown in figure 11. An rf source of 10 mW (+ 10 dBm) was used to drive the antennas in order to give a 20 dB signal-to-noise ratio at the receive site. The received signal strengths for the two antennas are shown as a function of frequency in figure 12.

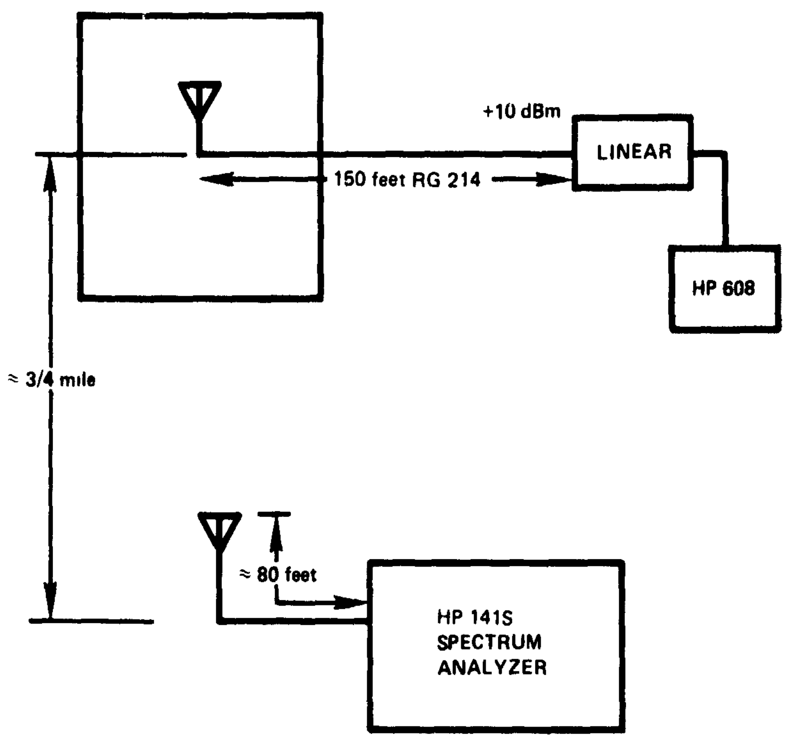


Figure 11. Test setup B.

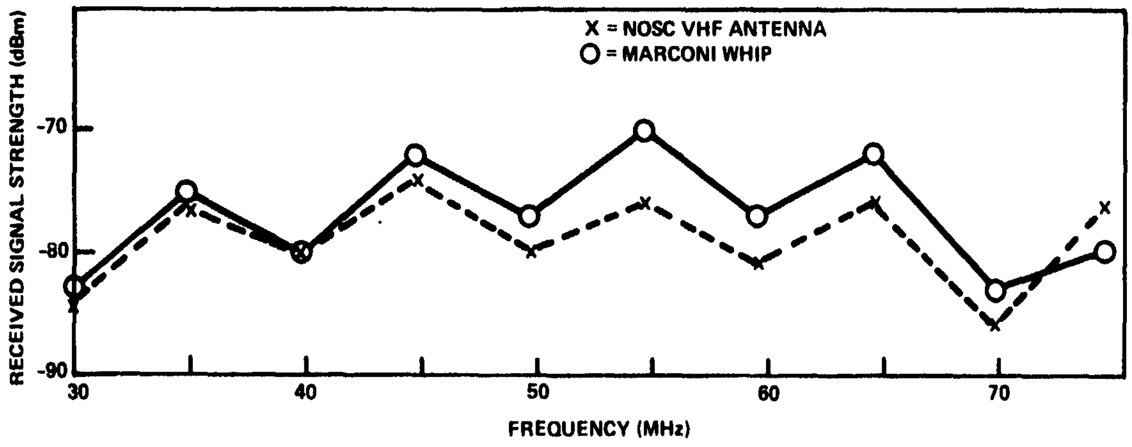


Figure 12. NOSC vhf antenna vs Marconi whip antenna over extended ground plane.

The complex input impedance of the antenna was measured at approximately 2 MHz intervals in the operating range using a vector impedance meter. The measured values were plotted onto a Smith impedance diagram (fig 13). Points inside the 3:1 VSWR circle represent frequencies where the antenna has an efficiency greater than 75% (the input transformer has an insertion loss of 0.5 dB).

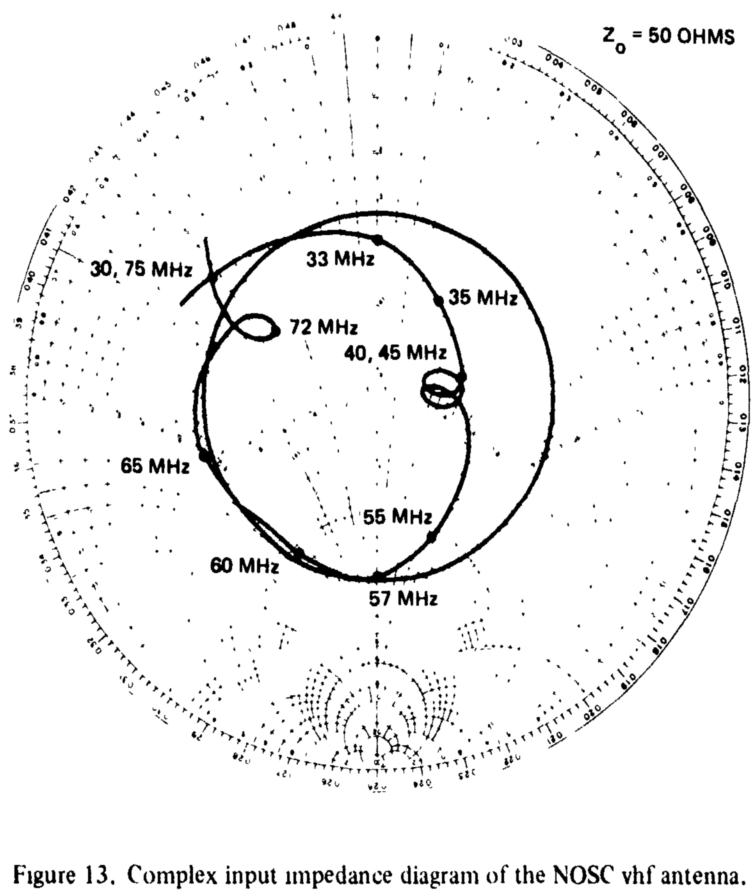


Figure 13. Complex input impedance diagram of the NOSC vhf antenna.

PROTOTYPE VHF ANTENNAS

The transition from the experimental model to a prototype was primarily a mechanical one. The experimental antenna consisted of a conductor taped to a fiberglass rod and an outdoor electrical junction box with the transformer inside. The rod was joined to the box using a short length of 3/4 inch teflon rod and a conduit fitting. This arrangement was very convenient for making adjustments in the design. The prototype antennas required an outer jacket to protect the conductor and a mounting base to contain the transformer, provide an rf feed-through, and be interchangeable with the AS-1729 base.

PRODUCTION OF PROTOTYPES

Two prototype whips were fabricated by Conolon Corp and sent to NOSC for testing. It was found that the curing process caused the resin from the jacket to wick along the conductor pigtail. This made it difficult to solder the pigtail to the transformer. Further, the outer jacket shifted the frequency response downward and for this reason the length of a jacketed whip was shortened to restore the 30-76 MHz frequency bandwidth. Conolon Corp was advised of the new dimensions and the need to tin the pigtail before assembly.

Two more prototype whips were fabricated, tested, and found to be satisfactory and as a result a production run of 12 was made. They were assembled with transformers and BNC connectors and potted into bases using polyurethane.

PROTOTYPE TESTS

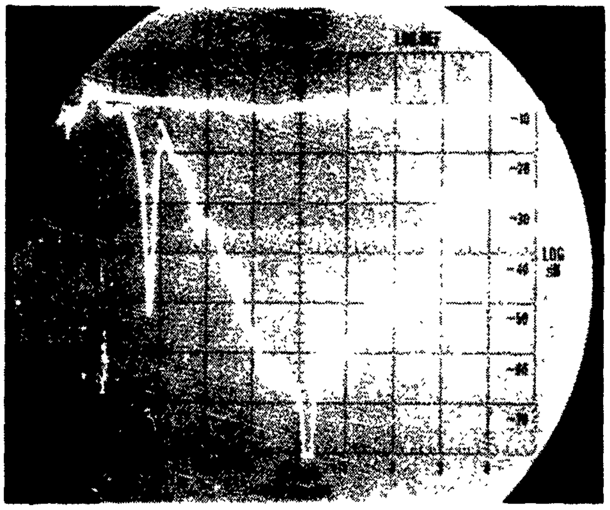
One prototype antenna was subjected to vibration at 1st and 3rd mechanical resonances for at least 2 hours each. Double displacements of 1/8 inch and 1/4 inch were used. During the test the antenna was excited with a -30 dBm tone-modulated carrier of 50 MHz and monitored by a communications receiver approximately 60 feet away. The received signal was continuous throughout the test.

One prototype was mounted vertically to a heavy cart with the base 3 feet off the floor and subjected to several blows of a 6-foot 2 x 4. The blows were delivered in shear to a point approximately half way up the fiberglass whip. The blows were of such a force that they caused the tip of the antenna to strike the floor. No electrical or physical damage was noted.

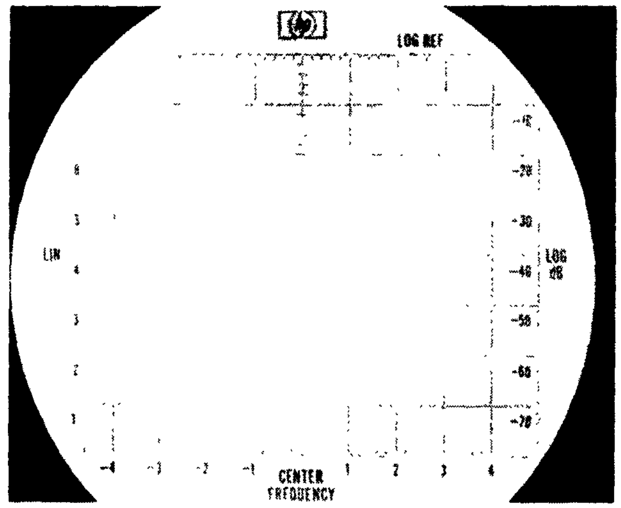
One prototype antenna was immersed in saltwater and exposed to sunlight for a week. Though corrosion of the mounting base was evident, no degradation of the electrical performance was noted. Appendix A presents the details of this test.

All prototypes were functionally tested by plotting their return loss as a function of frequency. Each was mounted to the back of a vehicle and a photograph taken of its return loss plot (fig 14).

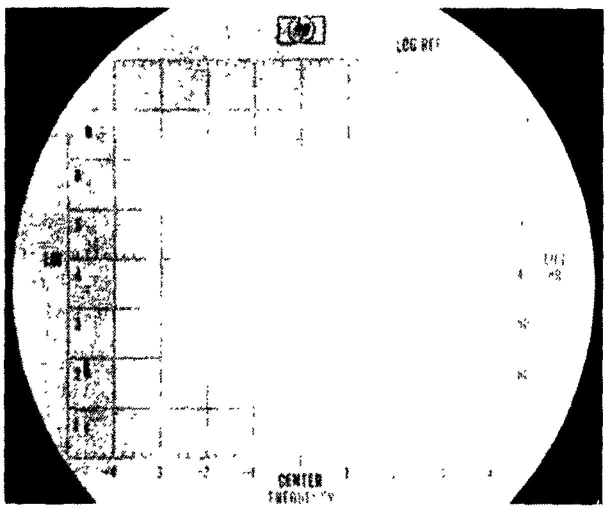
Figure 14 (prototype 01) includes a reference trace for 0 dB return loss. The horizontal display was set to 10 MHz/cm with a center frequency of 50 MHz and the vertical display was set to 2 dB/cm. Thus all points in a plot more than 3 cm below the reference trace represent frequencies at which the antenna is at least 75% efficient (assuming negligible insertion loss). Two things are remarkable about this series of photographs: the first



PROTOTYPE 01

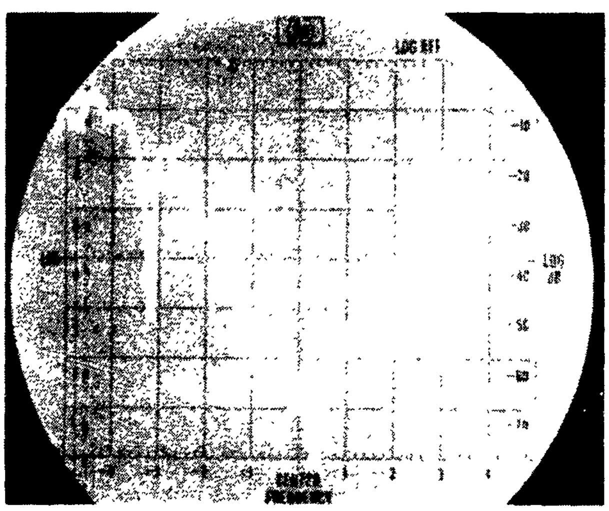


PROTOTYPE 02

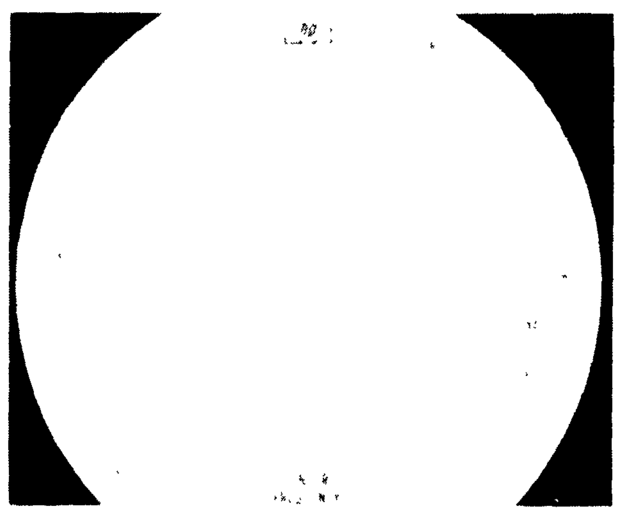


PROTOTYPE 03

PROTOTYPE 04

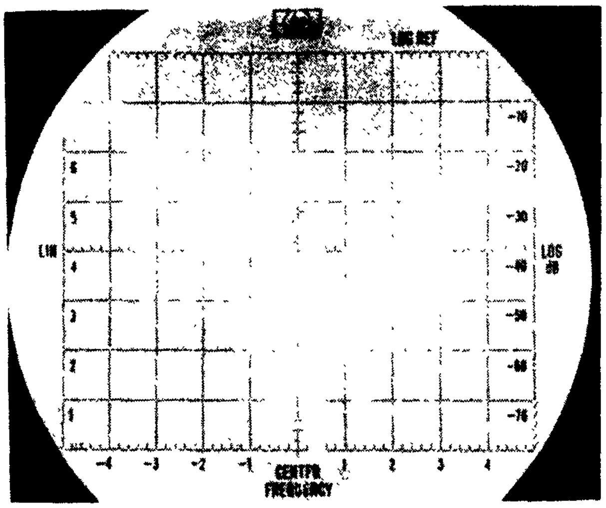


PROTOTYPE 05

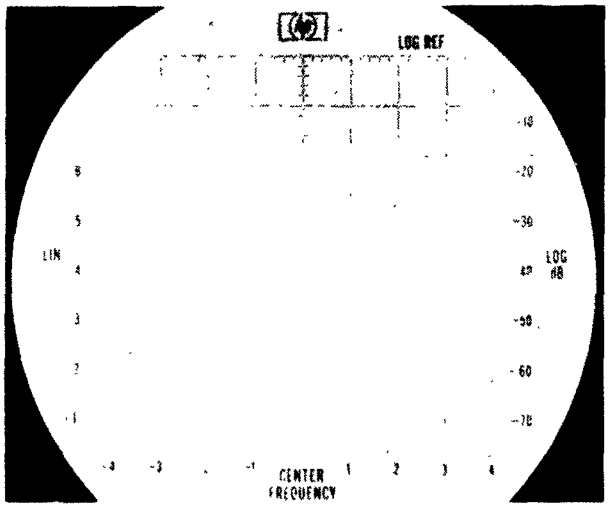


PROTOTYPE 06

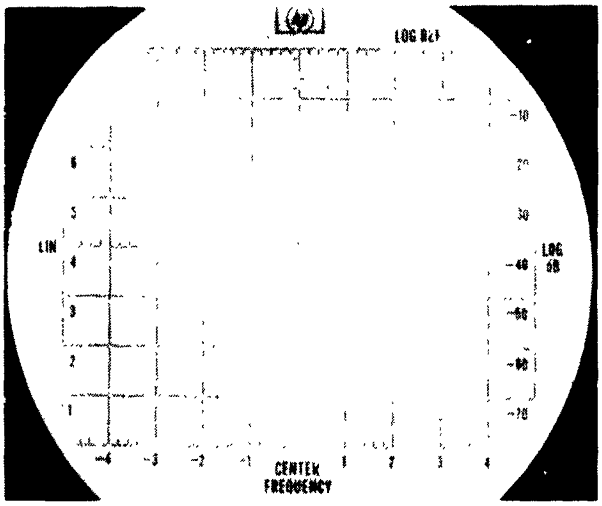
Figure 14. Return loss plots for prototypes (vertical display, 2 dB/cm, horizontal display 10 MHz/cm, centered at 50 MHz).



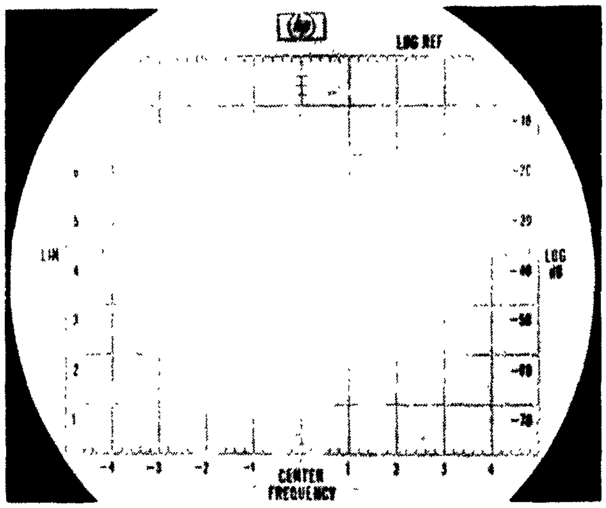
PROTOTYPE 07



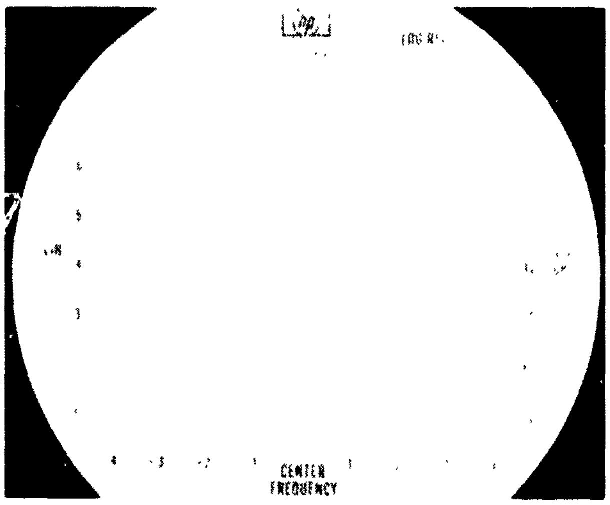
PROTOTYPE 08



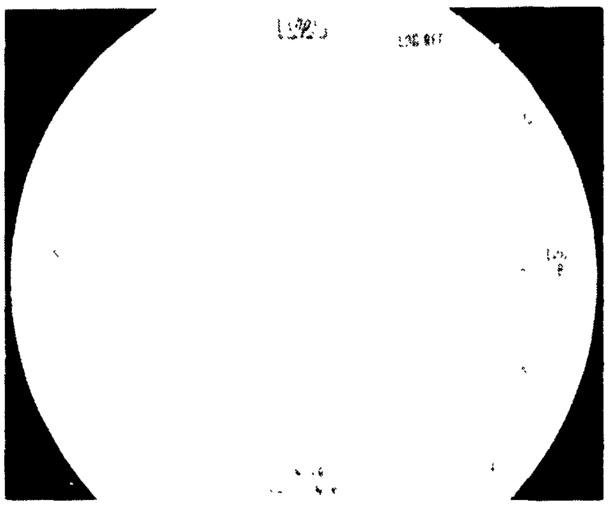
PROTOTYPE 09



PROTOTYPE 10



PROTOTYPE 11



PROTOTYPE 12

Figure 14. (Continued.)

is that 11 of them are nearly identical, an indication of the reproducibility of the antenna and the second is that prototype 03 is significantly better than the others near 30 MHz.

FIELD TESTS FOR WIDEBAND VHF ANTENNA

On 14-16 August 1978, field tests were performed on several developmental prototypes of the NOSC Wideband VHF Whip Antenna. The tests consisted of: a comparison of the new antenna with an AS-1729 whip deployed on a jeep at a distance of about 1 mile, a comparison of the new antenna with an RC-292, both mounted atop 30 foot masts, and a comparison of third order products generated by the new antenna and the Marconi antenna mounted on an LVTC-7 amphibious vehicle.

Test results indicate that the new antenna performs as well as or better than either the AS-1729 or the RC-292. However, the results from the LVTC-7 test are inconclusive and should be repeated after some further analysis and laboratory experiments.

FIELD TEST NARRATIVE

Generally, the field tests were performed as outlined in the test plan of Appendix B. Some modifications were required to accommodate equipment limitations and schedule delays.

A fixed base station was set up in a "Magic Van" near the communications company buildings. The van received primary power from a diesel generator and was outfitted with two RT-524 transceivers and two AS-1729 whip antennas. NOSC personnel installed a spectrum analyzer and powered it with 120 VAC, 60 Hz, via an extension cord.

A jeep was equipped with two RT-524 transceivers and one AS-1729 whip antenna. An NOSC prototype whip was mounted on the jeep opposite the AS-1729. The jeep was deployed to a point approximately 1 mile and out of sight from the Magic Van.

TEST 1

The jeep was parked with antennas toward the van. Short test transmissions were made from the jeep, first on the AS-1729 and then on the NOSC antenna. Received signal strengths on both antennas were too low to be measured on the spectrum analyzer. The background level on the spectrum analyzer was about -80 dBm.

A Nems Clarke fm receiver was used to measure the signal strengths; the signal strength meter readings were later converted to dBm.

Test transmissions were made on eight frequencies, 32.85–65.05 MHz.

Results of Test 1

On the four lower frequencies the NOSC antenna outperformed the AS-1729. On the four higher frequencies performance of the two antennas was the same. Received signal strengths as a function of frequency for Test 1 are shown in figure 15. The second half of Test 1 of Appendix B was deleted.

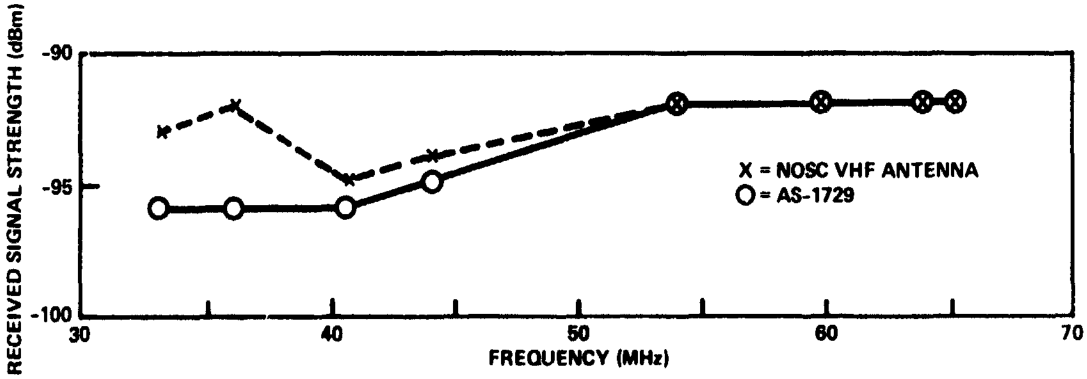


Figure 15. NOSC vhf antenna vs AS-1729 antenna jeep mounted.

TEST 2

A jeep equipped with two RT-524 transceivers was deployed to a point approximately 1 mile from the Magic Van and out of sight. At the remote site two RC-292 masts were erected about 50 feet apart. One mast supported an RC-292 antenna, the other supported an NOSC antenna with adaptor. Some difficulty was experienced in mounting the NOSC antenna because the adaptor mast fitting was the wrong gender. The base station was the same as in Test 1.

Test transmissions were made from the remote site on eight frequencies, 33.20-65.35 MHz. Transmissions were made first on the RC-292, then on the NOSC antenna at each frequency. The RC-292 was configured 3-up/4-down throughout the test.

Results of Test 2

On 40.45, 44.30, 64.05, and 65.35 MHz the performance of both antennas was the same. On 33.20, 36.25, 54.10, and 60.1 MHz, the NOSC antenna outperformed the RC-292. Received signal strengths as a function of frequency for Test 2 are shown in figure 16.

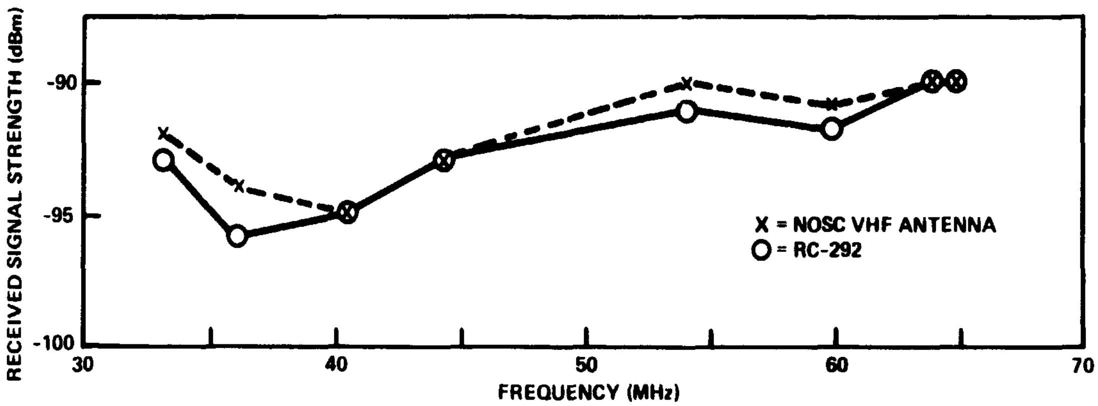


Figure 16. NOSC vhf antenna vs RC-292 antenna on 292 mast.

TEST 3

For the final test, the 6-channel multicoupler was moved from the Magic Van to the 3rd Assault Amphibious Battalion and installed in an LVTC-7 command tractor. Several RT-524 transceivers had been installed in the tractor and one AS-1729 tuning unit was removed to provide a mounting surface for the NOSC antenna. Unfortunately, neither NOSC nor Marine Corps personnel on hand were familiar with the operation of the multicoupler. However, a sheet of tuning instructions for the resonators was available and these instructions were used for Test 3. Because some doubt remains about the proper tuning of the multicoupler, details of the tuning used in Test 3 will be included here for future evaluation.

Adjustment of the Multicoupler

No resistive terminations were placed on unused channel inputs. One RT-524 output was patched to channel 3 input via a 6-foot length of RG-58 coax. The output of the multicoupler was patched to the NOSC antenna through a wattmeter using RG-58 coaxial cable.

The RT-524 was set up on 30.05 MHz and low power. With the auxiliary capacitor controls pushed in and the RT keyed up, the tuning meter was set at 2/3 FS, switched to TUNE, and resonators A, B, and C were respectively peaked, nulled, and peaked. With the RT on HIGH power and meter sensitivity full CCW, the RT was keyed giving a reading of 6 W forward on the wattmeter. The RT was then patched directly through the wattmeter to the antenna. Again the meter reading was 6 W. The RT was patched again to channel 3.

A second RT was set up on 36.50 MHz and patched to the channel 5 input. Channel 5 was tuned in the same manner as channel 3. On HIGH power the second RT gave a reading of 20 watts on the wattmeter.

Because the spectrum analyzer was suspect, it was not used in Test 3. The Nems Clarke fm receiver was connected to the channel 1 input and tuned to 42.95 MHz.

Measurement of 3rd Order Product

With both RT-524 transceivers keyed up, the receiver and then each of the resonators of channel 1 were tuned for a peak reading on the receiver signal level meter (the auxiliary capacitor controls of channel 1 were pushed in).

The NOSC antenna was replaced by the Marconi whip antenna. The RTs were keyed up again and the third order product measured on the receiver signal level meter. It was noted that with the Marconi antenna connected to the multicoupler output, the rf power in channel 3 was now 9 W (1.8 dB higher than before) while the rf power in channel 5 was still 20 W.

Results of Test 3

The third order product with the NOSC antenna was -83 dBm.

The third order product with the Marconi whip antenna was -61 dBm.

Even with a 1.8 dB difference in input power, it is difficult to believe that the NOSC antenna would produce 22 dB less 3rd order intermodulation than the Marconi whip antenna.

CONCLUSIONS AND RECOMMENDATIONS

The results of Test 1 and 2 indicate that the NOSC wideband vhf whip antenna prototypes are operationally compatible with AS-1729 and RC-292 applications. The NOSC prototypes may be employed in normal field operations without adversely impacting communications effectiveness. It is recommended that field testing of the NOSC antenna, in applications normally filled by AS-1729 and RC-292 antennas, be continued at Camp Pendleton at the convenience of the user and that antenna failures or functional peculiarities be reported to the cognizant NSAP representative. A list of operating instructions is given in Appendix C.

The results of Test 3 are inconclusive. Further analysis, consultation, and laboratory experiments will be required to establish the reliability of the test data. It is recommended that this test be repeated after the procedures used and the data have been evaluated.

The low levels of signals received at the Magic Van during Test 1 and 2, though not particularly detrimental to the tests, are a curiosity. In that the jeep and the remote antennas were out of sight from the van, it must be assumed that obstructions and multipath caused a considerable increase in propagation path loss.

SUMMARY

The NOSC wideband vhf whip antenna has been developed to a prototype suitable for field tests. One dozen prototypes were produced and nine of these were delivered to Camp Pendleton for field testing. Preliminary field tests have been made comparing the NOSC antenna to the vehicle-mounted AS-1729 and the mast-mounted RC-292. In these preliminary tests, the operational performance of the NOSC antenna equaled or exceeded that of both the AS-1729 and the RC-292. Field tests are now in progress at Camp Pendleton to evaluate the NOSC antenna mounted on an LVTC-7 command tractor.

Two patent disclosures have been filed on the NOSC antenna: NC63, 121, DM Dilley, NOSC and NC63, 398, DB Forman, NOSC.

Results of the tests performed and the experience of producing the prototype antennas indicate that the NOSC Wideband VHF Whip Antenna is a lightweight replacement for the AS-1729. The NOSC antenna is half the size of the AS-1729, less complex, less subject to moisture, a comparable performer, and only costs a tenth as much.

Figure 17 compares the complexity of the NOSC antenna with the AS-1729. Figure 18 shows a prototype S/N 01 ready for mounting on a vehicle and a second prototype already mounted to an adaptor for mounting the antenna atop an RC-292 mast.

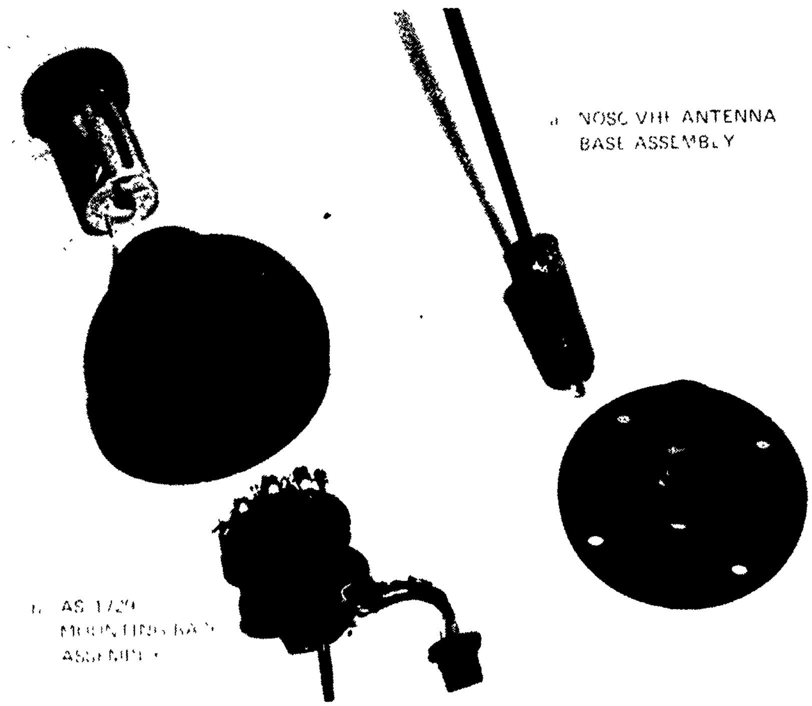


Figure 17. Comparison of mounting base complexity - NOSC vhf antenna vs AS-1729 antenna.

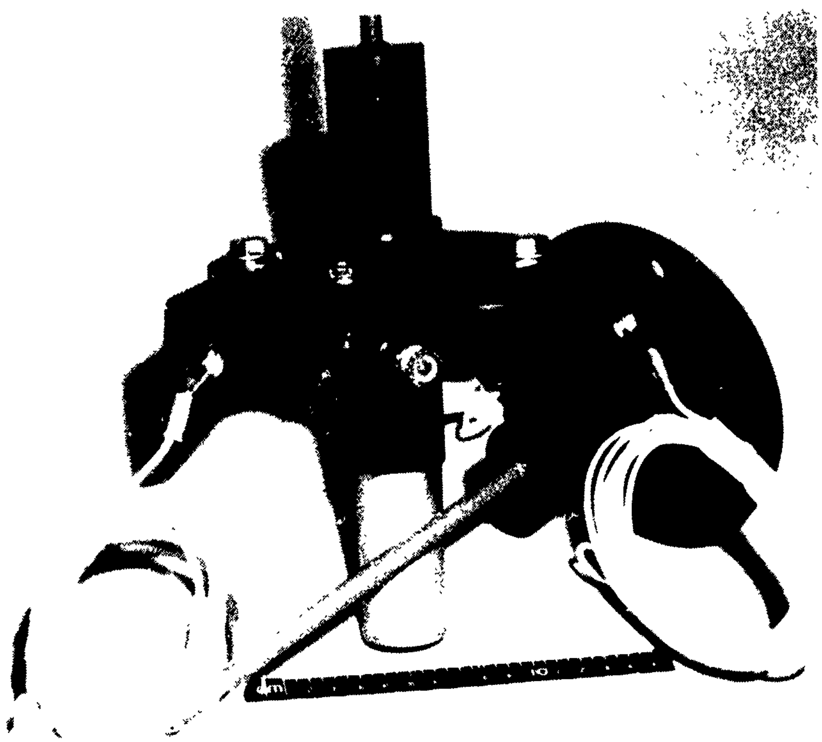


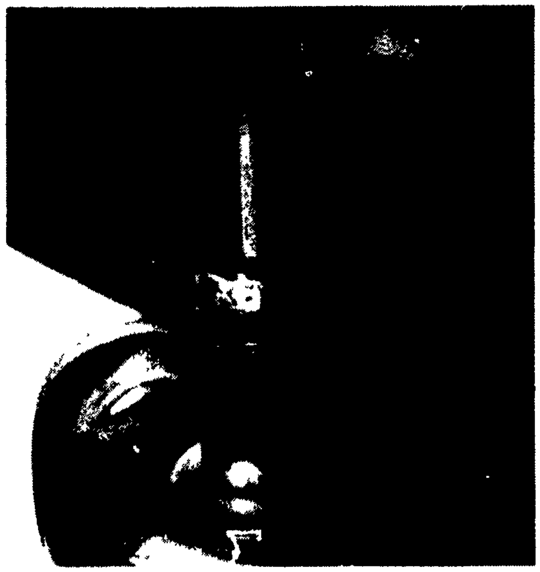
Figure 18. NOSC wideband vhf whip antenna (prototype 01 shown as used on vehicle, a second shown mounted on adaptor for RC-292 mast).

APPENDIX A:

SALTWATER IMMERSION TEST

Prototype 04 was immersed in tap water for 2 weeks, and then immersed in saltwater for another week. The corrosive effects of the saltwater are shown in figure A-1. The BNC rf connector was dried out and the antenna was mounted to a vehicle. The antenna was then wetted with saltwater and a return loss plot made using a spectrum analyzer and tracking generator. A plot of a dry prototype was superimposed over the return loss plot for comparison. These plots are shown in figure A-2a. After prototype 04 was dry, another return loss plot was made; this plot is shown in figure A-2b. The horizontal display in all plots was 10 MHz/cm, centered at 50 MHz. The vertical display on all plots was 2 dB/cm. A zero dB reference trace is shown in both figures. The return loss plot of 04 before saltwater immersion is shown in the main body of the text (fig 14).

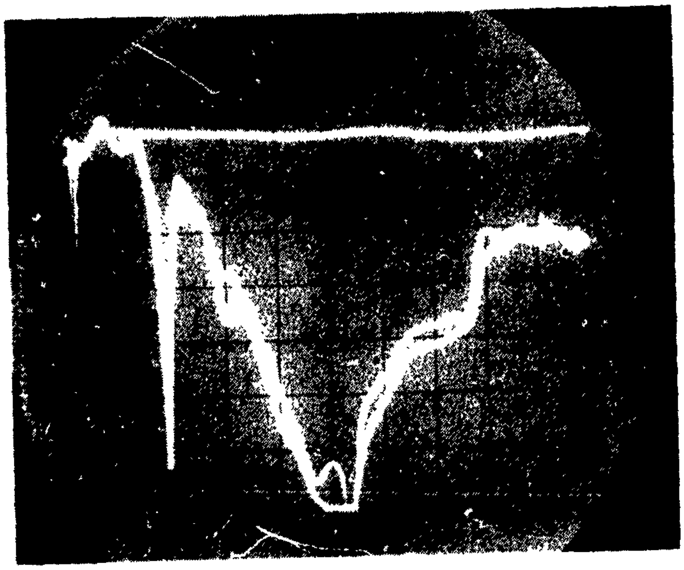
a. NOSC VHF ANTENNA WITH RC-292 ADAPTOR AFTER 1 WEEK IMMERSION IN SALTWATER.



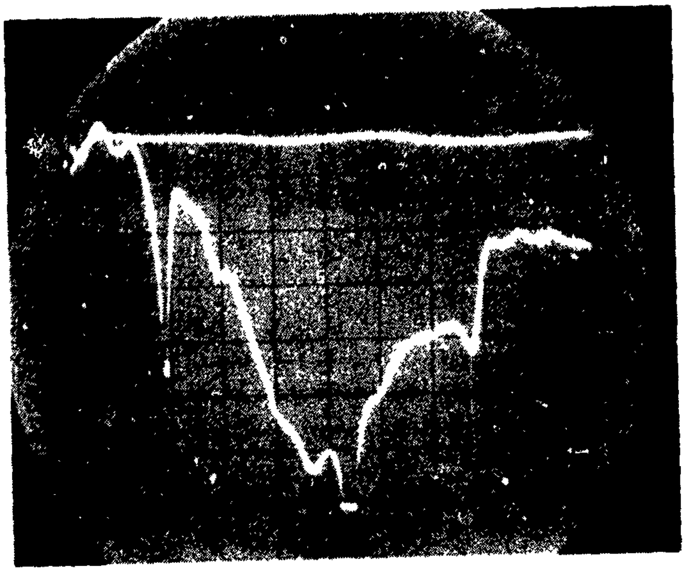
b. PITTING IN ALUMINUM BASE AFTER CORROSION WAS SCRAPED OFF.

c. NOSC VHF ANTENNA MOUNTING SURFACE AFTER 1 WEEK IMMERSION IN SALTWATER.

Figure A-1. Visual results of prototype 04 after immersion in tap water and saltwater.



a. COMPARISON OF PROTOTYPE 04 (WET) WITH ANOTHER PROTOTYPE (DRY). NOTE THAT 04 HAS A BROADER NULL NEAR THE CENTER OF THE TRACE.



b. 04 AFTER IMMERSION (DRY).

Figure A-2. Return loss plots.

APPENDIX B:

FIELD TESTS

PURPOSE OF TESTS: It is desired to establish early in the developmental phase, the utility of the vhf antenna in environments closely approximating those of the intended application, and to perform these tests as economically as possible.

The purpose of the new wideband antenna is to provide a vhf vehicular communications antenna which is economical to produce, has no electromechanical tuners, operates satisfactorily over the frequency range 30-76 MHz, and has a low profile. The field tests should establish the antenna's compatibility with unit mission, function in real environment and deployment, and durability and convenience in maintenance and stowage.

TEST #1 PERFORMANCE AS VEHICULAR VHF ANTENNA

The purpose of this test is to compare the performance of the new vhf antenna with an AS-1729 mounted to a jeep configured as a 110 communications vehicle (2 AS-1729 antennas and two RT-524 transceivers).

Facilities and equipment required:

a. Fixed base station with:

1. Two vhf antennas (RC-292 or AS-1729)
2. One RT-524 transceiver
3. Interconnecting cables

b. Jeep configured as 110 communications vehicle, capable of being deployed at least a mile from the base station and manned with a driver and a radio operator.

c. Frequency allocations in the range 30-76 MHz at approximately 5 MHz intervals.

Test Plan

a. NOSC personnel will replace one of the AS-1729 antennas on the jeep with the new vhf antenna. This installation will include the necessary electrical bonding of the antenna base to the vehicle antenna mounting fixture.

b. An RT-524 will be connected to one of the base station antennas for communication with the deployed jeep.

c. A spectrum analyzer will be connected to the other base station antenna for received field strength measurements.

d. The configuration for Test #1 is shown in figure B-1.

e. The jeep will then deploy to a site remote from the base station while maintaining communications on a frequency of about 30 MHz. Once in position, with antennas toward base station, the jeep will maintain sufficient idle speed to supply primary power.

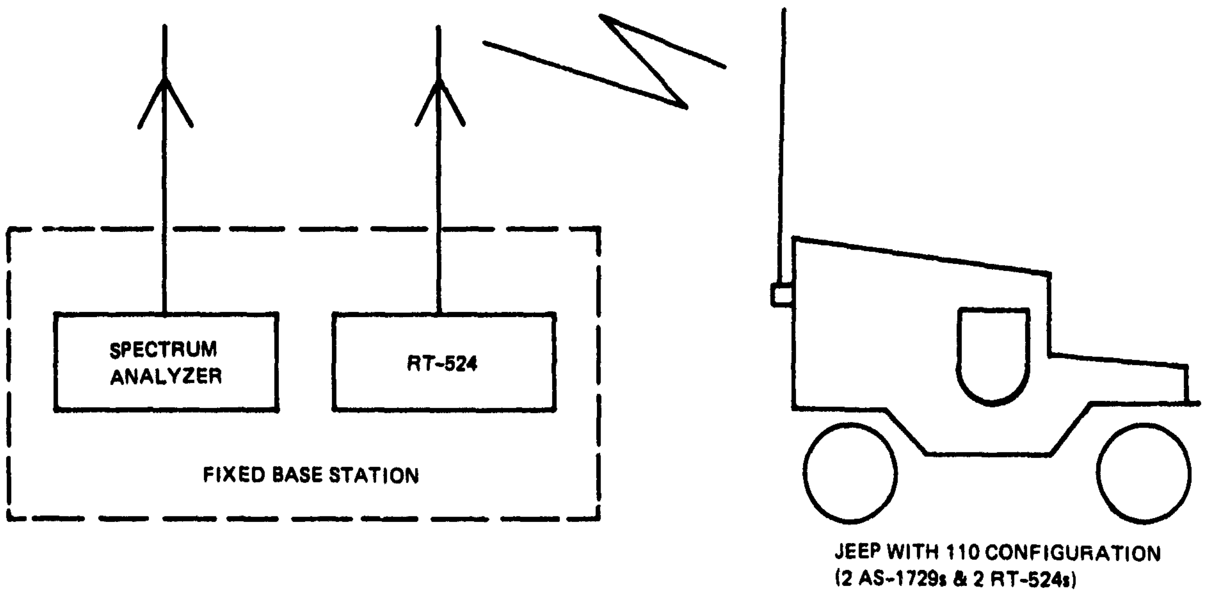


Figure B-1. Setup for test #1.

Using the RT-524 on the same side of the vehicle as the new antenna, the radio operator will make 10 second test transmissions on each of the allocated frequencies in sequence. At each frequency, first the AS-1729 will be connected to the RT-524 output for a 10 second transmission, then the AS-1729 will be disconnected and the new antenna connected to the RT-524 for a 10 second transmission. When tests are completed on all allocated frequencies, the jeep will be turned around so that its antennas are away from the base station and the test repeated starting at a frequency of about 75 MHz.

TEST #2 NEW VHF ANTENNA COMPATIBILITY WITH RC-292 APPLICATIONS

The purpose of this test is to establish the utility of the new antenna when mounted atop a 30 foot RC-292 mast.

Facilities and equipment required:

a. Fixed base station.

1. Two vhf antennas (RC-292 or AS-1729)
2. One RT-524 transceiver
3. Interconnecting cables

b. Jeep configured as 110 communications vehicle, capable of being deployed at least a mile from the base station, and manned with a driver and a radio operator.

c. Frequency allocations in the range 30-76 MHz at approximately 5 MHz intervals.

d. Two RC-292 antennas with coaxial adaptors to allow connection to the rf output of RT-524 transceiver. (NOSC now has one RC-292 antenna, so only one additional antenna is required.)

Test Plan

a. An RT-524 will be connected to one of the base station antennas for communications with the deployed jeep.

b. A spectrum analyzer will be connected to the other base station antenna for received field strength measurements.

c. The jeep with two RC-292 antennas and one of the new vhf antennas will deploy to a site remote from the base station.

d. At the remote site two RC-292 masts will be erected approximately 50 feet apart, one with an RC-292 antenna on top and one with the new vhf antenna on top. The test set up is shown in figure B-2.

e. Using one RT-524 transceiver, the radio operator will make 10 second test transmissions on each of the allocated frequencies in sequence. At each frequency, first the RC-292 will be connected to the RT-524 output for a 10 second transmission, then the RC-292 will be disconnected and the new antenna connected to the same RT-524 for a 10 second transmission.

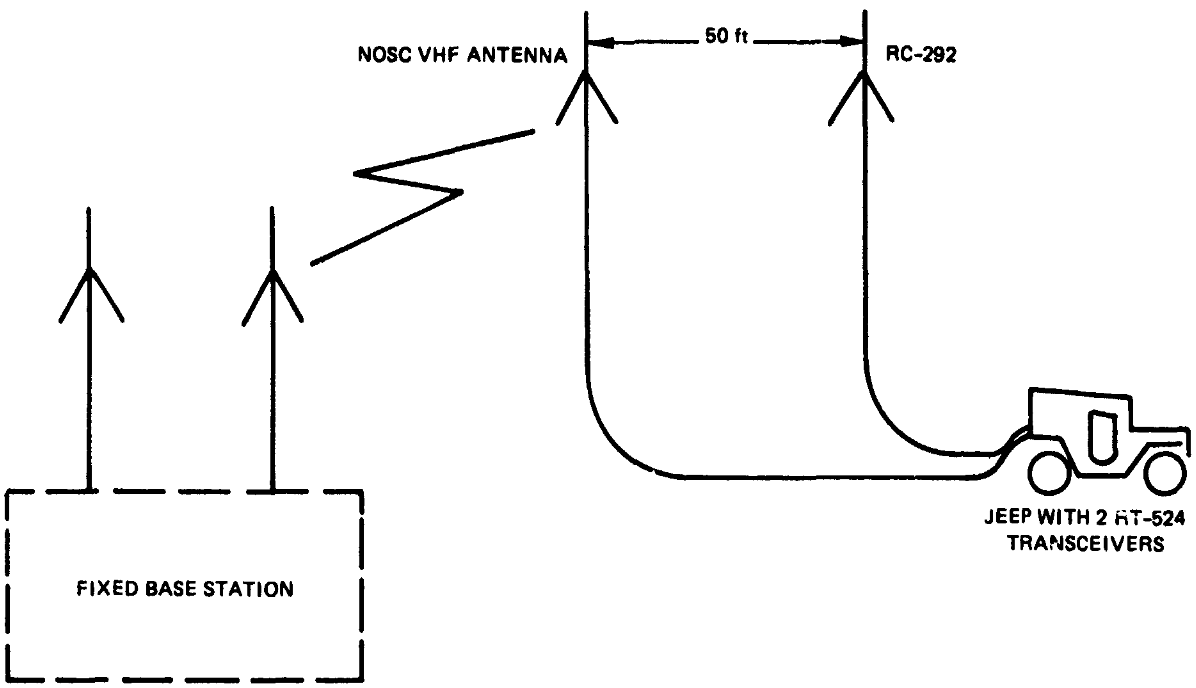


Figure B-2. Setup for Test #2.

TEST #3 LVTC-7 MULTIPLE-TRANSMITTER COMPATIBILITY

The purpose of this test is to establish the utility of the new antenna as a wide instantaneous bandwidth device used in conjunction with multiple transmitters via a multicoupler.

Facilities and equipment required:

a. LVTC-7 vehicle capable of providing primary power for two RT-524 transceivers.

b. Two RT-524 transceivers

c. Six-channel multicoupler

d. Interconnecting cables

Test Plan

a. NOSC personnel will install wideband antennas for testing on the LVTC-7 vehicle and will connect a spectrum analyzer to one of the receiver ports of the multicoupler.

b. The test setup is shown in figure B-3.

c. With two RT-524 transceivers working into the multicoupler, third order IM products will be measured.

d. The new antenna will be compared with the Marconi vhf whip for IM generation.

e. Other tests will be performed as time permits.

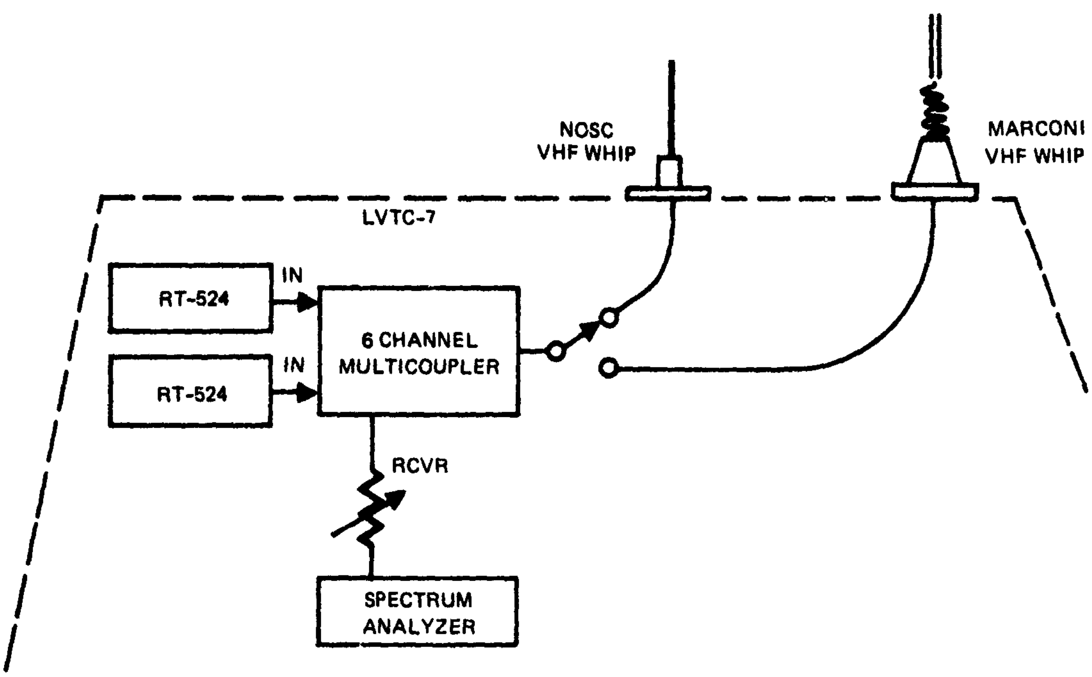


Figure B-3. Setup for Test #3.

APPENDIX C:

INSTALLATION AND OPERATING INSTRUCTIONS

1. ANTENNA DESCRIPTION

The NOSC Wideband VHF Antenna is a 71 inch fiberglass whip with a 5.5 inch mounting base compatible with mounts now used for AS-1729 antennas. The antenna uses integrated compensation in the radiating element to achieve a 3:1 or better standing wave ratio over most of the band 30–76 MHz without auxiliary electromechanical tuners or lumped-constant reactances in the base. The feed-point impedance of the antenna is nominally 50 ohms via a BNC type coaxial connector at the base mounting plate. The prototype antennas are designed for a maximum input power of 75 watts.

2. ANTENNA INSTALLATION

The NOSC Wideband VHF Antenna is designed to operate mounted on a metal surface. Before installation, all paint and corrosion should be removed from the mounting surface so that a 5-inch diameter, bare metal patch will contact the unpainted bottom surface of the antenna base. A conductive gasket is provided so that both moisture sealing and electrical continuity may be maintained.

The base mounting plate of the prototype antennas is made of 6061-T6 aluminum. The antenna may be mounted using 5/16 or 3/8 bolts without cracking the base plate.

The antenna should be fed with 50 ohm coaxial cable. Care should be taken during installation not to injure the BNC connector in the antenna base.

3. ANTENNA OPERATION

The antenna is designed to have a wide instantaneous bandwidth. Therefore, it will operate anywhere in the frequency range 30–76 MHz without auxiliary tuning networks. Further, if suitable transmitter rf combiners are available, the antenna may be operated at several frequencies in the range 30–76 MHz simultaneously. However, the total power of all signals going to the antenna should not exceed 75 watts for the prototype antennas.