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AN/PRC-56 HELMET RADIO SET UPGRADING. RECOMMENDED MODIFICATIONS--ETC(U)

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Technical Document 105

AN/PRC-56 HELMET RADIO SET UPGRADING

Recommended modifications require minimal resources but promise considerable improvement in reliability, operability, and logistics support

JH Townsend

Approved for public release; distribution is unlimited

15 May 1977

Prepared for
NAVAL ELECTRONIC SYSTEMS COMMAND
Telecommunications Division (ELEX 510)

Period from July 1976 to April 1977

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ADMINISTRATIVE INFORMATION

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The enthusiastic support of EJ Paihinui, Jr, and KI Ueno and the cooperation of their supervisor, D Dionisio, of the Naval Electronic Systems Engineering Center, San Diego, were essential to the successful completion of this project. Their experience in the maintenance of the FDCS contributed greatly to the formulation of the proposed changes, and their expert assistance is gratefully acknowledged by the author.

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OBJECTIVE

The AN/SRC-22(V) Flight Deck Communication System (FDCS), especially the key AN/PRC-56 Helmet Radio Set, is obsolescent and is experiencing maintenance problems. This project was to investigate, analyze, and recommend simple solutions for the most severe of those problems.

RESULTS

A number of simple actions, which are well within the capabilities of ship's forces, have been identified. These actions should reduce failure rates significantly. Additional identified changes will enhance the operability and user tolerance of the AN/PRC-56.

RECOMMENDATIONS

1. Implement the identified actions through a field change (see appendix A for the proposed field change) and approve the recommended engineering change proposals (see appendix B).
2. Improve the procurement of PRC-56 batteries by instituting more stringent quality control and by supporting design changes to incorporate improved battery technology. Development of a second source may be warranted.
3. Support the development of a new, nonfluid ear seal with the acoustic attenuation and fit advantages of glycerine.
4. Increase the allowance for AN/PRC-56s to allow most users to be assigned a unit for personal use.
5. Incorporate more standard parts into the system wherever possible to improve both reliability and logistics support.

INTRODUCTION

BACKGROUND

The AN/PRC-56 Helmet Radio Set is an important unit of the AN/SRC-22(V) Flight Deck Communication System (FDCS). The FDCS capabilities are essential to sustained air operations on aircraft carriers and are critical to flight deck safety on CV, LPH, and LPD class ships so equipped. The FDCS has demonstrated its role in averting serious accidents and in limiting damage when catastrophes do occur (ref 1). However, trends in reported maintenance actions show that the systems have reached obsolescence and are deteriorating unacceptably (ref 2). Actions are required to halt or slow the deterioration and reverse the trends, if possible. The AN/PRC-56 is a prime target because it has a much higher population than the other SRC-22 equipments, because it is subjected to the most severe environments, because it is such a key element of the FDCS, and because the extent of its maintenance far outweighs that of the remainder of the system.

The Center's role in the development of the FDCS in the 1950s, which proved the feasibility and provided the concepts and technical requirements to the subsequent development and production of the SRC-22, and its continuing role in FDCS developments provided the unique capabilities and background to investigate what might be done to improve the situation. The Naval Electronic Systems Command provided tasking to investigate and recommend actions which would improve the operation and reliability of the FDCS, particularly the PRC-56. Since a new secure FDCS is under development which will begin replacing the SRC-22 in about 5 years, actions which required few resources but offered large impact on the problems were desired. Major redesigns of the equipment could not be justified. Appropriately, the task funding was limited. Recognizing these restrictions, Center personnel accepted the challenge.

APPROACH

The purpose of the project was to upgrade and improve the existing flight deck communication system pending the availability of a new secure FDCS. A decision was made to concentrate on the AN/PRC-56 helmet radio because funding was limited. The system commonality assures that some of the improvements designed for the PRC-56 will also benefit the hand-held PRC-55 and the base station units. Also, improvements to the PRC-56 have much greater impact than gains for the other system units since there are many, many more helmet radios than all other system units combined.

Some problems were known at the start through work with the Fleet and Type Commanders, through personal experience, from prior studies conducted in support of the secure FDCS Development Program, and from material provided by the sponsor, Naval Electronic Systems Command (Code 510138). Additional problems were identified through Material History Reports and Parts Usage Reports from the Maintenance Data Collection System (MDCS) covering all the FDCS equipments. The Material History Reports provide brief texts describing the problem diagnosed and the corrective action taken by ship personnel; the Parts Usage

¹ Naval Safety Center Job Number 33054-BB of 14 December 1973, Machine Listing of Accidents/Incidents Having to Do with Air Operations Aboard Ships FY70-FY73

² DART Tracking Report 2, Maintenance Support Office, Mechanicsburg, PA, 17055, of 25 August 1975, MSOD4790S.3015

Reports enabled identification of high-replacement-rate items in the Fleet. The MDCS information tracked closely with the problems identified through direct Fleet contacts; however, extensive maintenance is conducted by the repair depots at San Diego and Norfolk. Interviews of the depot maintenance personnel at San Diego revealed additional problems which appear uniquely at the depot level and clarified the nature of some of the technical problems. A summary of the identified problems is provided in table 1.

Many of the apparent problems required additional analysis to determine the underlying causes. This was particularly true of the operator-associated items; furthermore, many of the problems were interrelated. The identification of cause-effect relationships was essential to the development of practical solutions. Fleet and depot maintenance personnel were extremely helpful in confirming the suspected causes.

The proposed solutions were expected to fall into one of three categories: those to be implemented by field change aboard ships, those to be accomplished under change orders to the depot repair facilities, and those requiring headquarters actions. It was desired to make as few changes as possible but to accomplish as many as possible through a field change, since this would be the most expeditious and least expensive alternative. For all field change proposals, the materials and parts were limited to those which could be obtained through the National Stock System, and the procedures and processes were limited to simple error-tolerant actions. The depot changes were also limited to materials and parts which were already supported, but more complex tasks were allowed. All parts, materials, and procedures were tested functionally and environmentally before including them in the recommended changes.

TABLE 1. SUMMARY OF PROBLEMS.

Problem Number	Description
1	High-failure-rate items: <ol style="list-style-type: none"> a. Battery (type 7V0.180SC) b. Audio amplifier module c. Toggle switch (push-to-talk) d. Toggle switch (on/off) e. Earphone cushion f. 2N741A transistor (transmitter final/frequency doubler) g. Electrical cap (battery contact) h. M-87 microphone, microphone cord, and mike boom i. PC132A semiconductor (Si varactor) (modulator and tripler) j. Squelch module k. Cable assembly connecting between pods l. Capacitor (TNT356U012P18) (used extensively in audio circuits; failures account for approximately three-fourths of actual audio amplifier and squelch module failures)
2	M-87 microphone is susceptible to saturation by wind.
3	Squelch adjustment is too critical and mechanically unstable.

TABLE 1. (Continued)

Problem Number	Description
4	PC boards expand and cause intermittent connections, especially feed-through grounds.
5	Tuning slugs in variable inductors are mechanically unstable.
6	Transmitter and receiver will not maintain alignment.
7	Receiver front end lacks gain.
8	There is no standby position for the earpods.
9	Units have severe pressure points on top of head and around ears.
10	There is an inordinately high unit replacement rate.
11	There is no sidetone. Sidetone improves the speaker's enunciation in high-level noise and reduces vocal strain, thus improving intelligibility.

EFFECTS AND CAUSES

GENERAL FACTORS

The problems listed in table 1 were not the exclusive offenders; rather, they are the primary sources of unreliable operation and unsatisfactory performance. The causes of these problems can be categorized as operational, environmental, or design factors. There are also synergistic effects which are significant. An analysis of the various factors illuminates their effects and indicates the constraints on any appropriate solutions.

The primary operational factors relate to the tolerance displayed by the user toward wearing the PRC-56. The unit must be worn under conditions which are already uncomfortable, but it is tolerated during operations because it provides communications which are essential to flight deck tasks and safety. In the midst of the flight deck activity, the uncomfortable or objectionable features are disregarded; however, the unit is doffed whenever operations permit because of problems (8) and (9) (see table 1). Furthermore, some users unconsciously are irritated by the unit. The net result is a great amount of abuse to the radio from being tossed carelessly into a corner or even being thrown angrily to the deck. It has been demonstrated that this type of abuse is greatly reduced when the radio is assigned to an individual user. This rough treatment requires the various adjustments to be mechanically stable and the unit design to be rugged. A less serious factor is that the users wear gloves; therefore, they cannot feel when the push-to-talk and on/off switches are actuated (ref problems 1c and 1d). Another operator element regards the use of the M-87 noise-canceling microphone. The placement for the M-87 relative to the user's mouth is critical to its performance. If the mike is placed directly in front of the mouth, "p" sounds will saturate the element and cause a momentary loss of output, and "s" sounds will receive unusual emphasis. On the other hand, the M-87 must

be close to the mouth to obtain the maximum output and to attain its noise-canceling properties. It is difficult to train operators to position the M-87 optimally, especially during the hectic pace of flight deck activity. The M-87 should be placed at the corner of the mouth less than ¼ inch (6 mm) from the lips. The net effect of these operational factors is to reduce the level of performance of the radio markedly and to cause a high unit failure rate.

Three environmental factors interact with the PRC-56 design to cause problems: high acoustic noise, heat, and wind.

The high levels of ambient acoustic noise encountered on the flight deck constitute the primary justification for the flight deck communication system. Some normal operating positions experience nominal noise levels in excess of 130 dBA and peak levels to 152 dBA. The noise is coupled into the electronics pods at levels sufficient to cause high-frequency mechanical oscillations in the radio components.

Heat is a major cause of problems in many electronic equipments, especially transistorized equipments of the vintage of the PRC-56. The heat is the result of direct sunlight, aircraft engines, and normal operating climates rather than power dissipation within the equipment. While no data are available on the actual temperatures reached within the electronics pods, thermal effects have been demonstrated in the PRC-56 which contribute to high-failure-rate problems at temperatures which are common on flight decks.

Wind is a requirement for flight operations, so winds of 35-40 knots are not uncommon on the flight deck. Unfortunately, the M-87 microphone is susceptible to saturation by wind (ref problem 2). When the microphone element is saturated, a momentary loss of output occurs. Other severe environments (such as salt air and corrosive atmospheres, high humidity, extreme cold, and high electromagnetic interference (EMI) levels) are encountered on the flight deck, but no effects were discovered to link them to problems in the PRC-56 aside from an annoying periodic buzz of induced EMI.

Design factors are the real culprits behind the PRC-56 problems. However, the design was state of the art when it was conceived and the PRC-56 is the best transceiver currently available for flight deck communications. The primary factor is the use of now obsolete technology. Inadequate design caused either by a lack of technical information or by changed requirements (eg, higher noise levels) ranks a close second in importance. Some of the design problems can be addressed individually, but most cannot be solved without extensive redesign.

HIGH-FAILURE-RATE ITEMS (ref 3)

BATTERIES AND CONTACTS

The battery used in the PRC-56 is a special construction nickel-cadmium cell, Gulton type 7V0.180SC (a commercial type with a special terminal). Although the battery has a very high failure rate, it has a low usage factor for supply system purposes because it is a special item. The batteries are procured sole-source from Gulton in large enough quantities that many have expired shelf-life times when they are drawn from supply, but these quantities have never been large enough to qualify a second source (there is no other commercial product similar to Gulton's) or to update the internal design. The cell's internal construction requires a vent to release overpressures of gas. This vent is normally sealed and is supposed to reseal automatically. Each time the battery vents, moisture is lost, resulting in a loss of charge capacity.

³Parts Report, MSOD, Mechanicsburg, PA, 17055, folder SS058 of 7 August 1976, MSOD 4790.S6271-04

Furthermore, the venting releases acids which are highly corrosive to the battery contacts. Venting in the PRC-56 batteries can occur at elevated room temperatures (30°C). Newer Ni-Cd battery constructions are designed to chemically react fast enough to avoid the formation of internal gases, thus allowing the battery to remain completely sealed at temperatures to 65°C. This newer technology would greatly reduce the battery replacement rate and the electrical contact failure rate. In any case, the batteries should not vent at temperatures as low as 30°C when not in use, but they do. Since some of the batteries (all of the same procurement lot) examined have held seal up to at least 50°C, the failure appears to be a manufacturing quality problem which might be addressed by the purchasing documents. The battery problem must be considered serious.

ELECTRICAL PARTS

The miniaturization problem was a major design challenge at the time the PRC-56 was developed. Many of the parts selections were severely constrained by size considerations. One of the resulting conditions is that many nonstandard parts were incorporated into design. These parts often lacked the quality control commonly associated with MIL-SPEC standard parts or high-grade commercial parts and also did not have the quality of high-volume-manufacture commercial parts. Some of these parts are difficult to obtain, and many can now be replaced by military standard parts. Several of these miniaturized parts are serious problems.

One of the parts identified as a high-failure-rate item is a 35- μ F tantalum capacitor which is designated TNT356U012P18. This miniature capacitor is used extensively in the audio circuits (audio amplifier, squelch module, noise AVC module, discriminator, low-level audio module, and clipper module). In these circuits, the capacitor accounts for a disproportionate number of module failures. Both the audio module and the squelch module appear in the list of high-failure-rate items; while they are both relatively complex and are both subject to a high false removal rate, the TNT356U012P18 failures account for approximately three-fourths of the failures of these modules. A failure in this capacitor can be predicted by the appearance of a black spot in the waxed end (see fig 1). It is now virtually impossible to get exact replacements; however, an established reliability capacitor is now available as a replacement in a style CLR65 T1 case. The replacement is a 33- μ F, 15 volt, 10- or 20-percent tolerance item. The following military parts numbers are designated for the 10-percent tolerance parts; they are listed in descending order of preference:

M39006/09-6879

M39006/09-6674

*M39006/09-6469

M39006/09-6264

M39006/09-6059

The part numbers represent various reliability levels; only the one marked with an asterisk is in the National Stock System (NSN 5910-00-010-8015, listed at \$3.29 each). If the -6674 or -6879 becomes available, either is preferred to the -6469. This MIL-SPEC part is just able to fit into the space designated for the capacitor, and, in fact, may not fit in some modules because repeated servicing has squeezed the two module boards together; the modules can be resoldered to allow enough space. Substitution of the MIL-SPEC part will greatly improve the audio circuit reliability and the availability of replacement parts.



Figure 1. A TNT356U012P18 capacitor which will fail soon. The black in the top portion is electrolyte leaking out of the primary section.

SWITCHES

The miniature toggle switches used for the push-to-talk and on/off functions are both high-failure-rate items. Their respective replacement rates are each exceeded only by those of the above capacitor and the batteries. Neither switch is rugged, but both are subjected to severe strain. A common failure results from too much pressure applied to the toggle bathandle. The bathandle itself is easily broken, and the internal connections are also fragile. Since flight deck personnel wear gloves and the switches have a very soft action, users cannot feel or hear the switch action and tend to push hard to ensure the switch is "on"; damage to the switch often occurs.

The push-to-talk switch has momentary spdt contacts. Power to the receiver is provided through the normally closed contacts, and power to the transmitter is wired through

the normally open contacts. The best mechanical solution to the push-to-talk switch problem is to replace the existing toggle switch with a pushbutton switch. Miniature pushbutton switches with the rugged characteristics needed are readily available; two MIL-SPEC types were identified – M8805/64 and M8805/96. Both the M8805 switches are spst rather than spdt; however, this is a reconcilable difficulty. Also, although there is space for the switches, the mounting hole must be relocated slightly to fit them into the case. To resolve the spst/spdt difference, the receiver section was wired on, bypassing the push-to-talk switch, and worst-case tests (transmitter and receiver on the same frequency) were conducted to measure circuit stresses and to ensure no reliability problems would be introduced. This same fix was suggested independently as a solution to the problem of lack of sidetone (problem 11), since it allows the speaker to hear himself through the base station retransmission. Both the M8805 styles are satisfactory in fit and function. The M8805/96 has a more positive action and requires less force to operate, but the M8805/64 has a shorter plunger travel, which is compatible with a M5473/10-01 boot seal. Also, the M8805/64 is somewhat less expensive and easier to install; therefore, it is recommended as the replacement push-to-talk switch (fig 2).

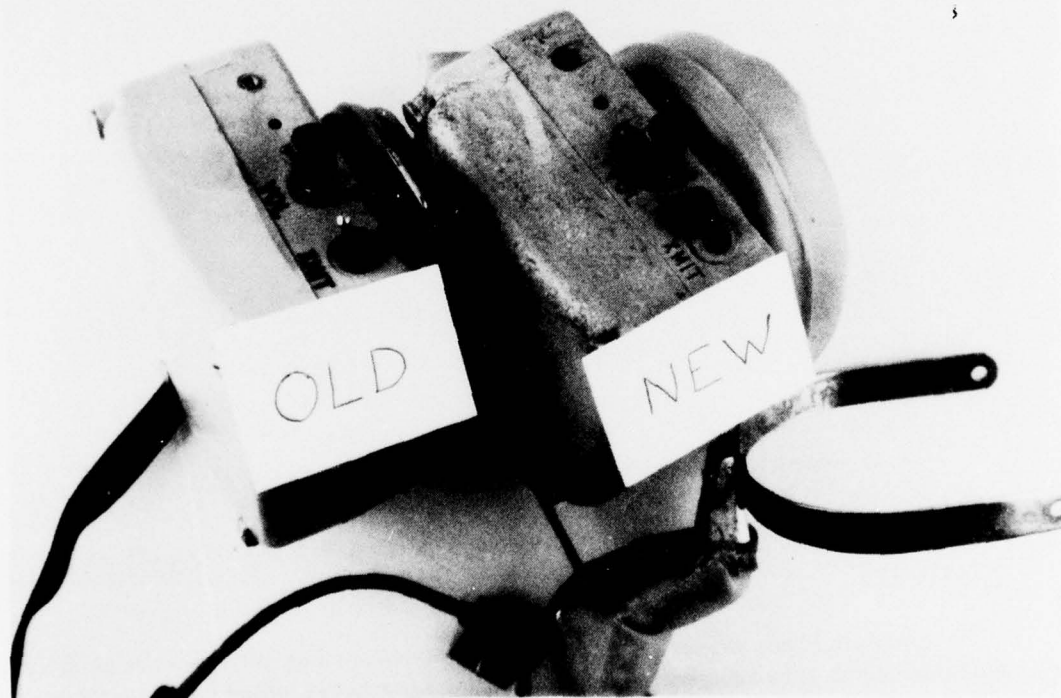


Figure 2. The old and new push-to-talk switches. Notice that the new switch is relocated and that the switchguard has been removed. The hole resulting from the switch relocation has been filled with epoxy.

The on/off switch (fig 3) presents a different problem. The switch should provide a visual indication of its position in addition to being more rugged and dependable. Three types of switch were considered – toggle, slide, and rotary. No slide switches were found which

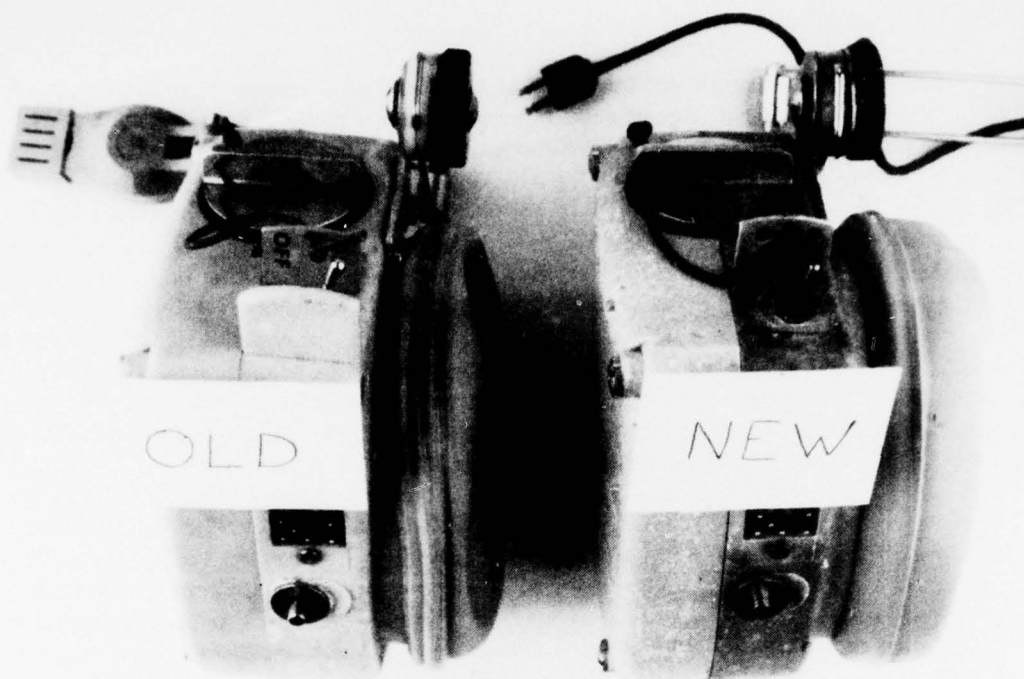


Figure 3. The old and new on/off switches. Notice also the alternate foam-filled ear cushion.

could be environmentally sealed and which could fit the spaces in the PRC-56 and the PRC-55. Several toggle switches and a rotary switch were identified which could fit, but all the candidates require a case modification. The candidates are as follows:

ALCO Electronics Products, Inc	MST215M	5930-00-880-9878
Components Specialties, Inc (CSI)	T3103	5930-00-578-9817*
MIL-SPEC toggle	MS24655-241	5930-00-459-5387
MIL-SPEC rotary style SR20	M3786/20-035	5930-00-203-5819
(requires knob - MS91528-OC1B, 5355-00-057-7794)		

Of these alternatives, the ALCO switch requires the least case modification; but while this switch is mechanically more rugged, its electrical contacts are only slightly more reliable than those of the existing switch. The CSI switch and the MIL-SPEC switches are all significantly more reliable and dependable than either the ALCO or the current switches; however, they are all sufficiently long to be subject to interference from the RFI filter board in the transmitter pod. If any of these latter three switches are used, the RFI filter assembly should be moved approximately 1/8 inch (3 mm) up in the pod. The other case modifications to the PRC-56 involve removing a block of excess plastic from the inside of the case next to the mounting hole and removing the outer switchguard. The MS24655-241 is the recommended replacement.

*The CSI T3103 is only one of many switches of similar construction provided by this NSN; any of these switches will work.

EARPHONE CUSHIONS

The earphone cushions for the PRC-56 are filled with glycerine. Glycerine is the best material known for effecting a good acoustic seal between a hearing defender and the user's head. It conforms to head variations and does not conduct noise efficiently. However, glycerine is a fluid, and the earphone cushions often develop leaks. Glycerine leaks into the electronics pods, destroying some of the protective foams and being absorbed by the printed wiring boards; it also leaks onto the user and becomes disturbing. The foam pads often used with hearing defenders do not provide so effective a seal nor such inefficient conduction of noise; since the PRC-56 is severely noise limited, the advantageous properties of glycerine are required. The next-best proved filler for earphone cushions is a silicone gel which does not perform so well as glycerine and which can still ooze out of the cushion. A promising new candidate is a urethane gel which appears to have properties approximating those of glycerine, but which is a formable solid. The development of a suitable replacement for glycerine should be supported, as it would be an advantageous improvement to the PRC-56 and many other equipments.

As an interim measure, three vinyl-covered foam earseals were identified. They are recommended only for those flight deck personnel not involved in catapult operations or other areas of the most intense noise conditions, since they are several dB less effective in attenuation than the glycerine pads. The foam pads are lighter and, for some users, more comfortable, and there is nothing to leak out. The three earseals are: Astrocom part number 10215, Gentex part number 74C2698, and Gentex part number 70C2196. These seals are essentially equivalent and are available under NSN 8475-00-940-9249 (\$2.50).

SEMICONDUCTOR PARTS

The 2N741A transistor used as the transmitter final and frequency doubler and the PC-132A silicon varactor used as the modulator and as the frequency tripler were both identified as high-failure-rate items. The stresses on both were analyzed to determine possible failure causes. Although normal circuit parameters revealed no suspicious characteristics, an analysis of EMI-induced transients during high-temperature operation revealed (1) excess power dissipation within the device and (2) overvoltage conditions at the semiconductor junctions.

The PC-132A characteristics were compared to MIL-, JAN, and JAN-TX silicon varactor specifications to determine candidates which could be directly substituted, which exhibited improved performance against the stresses identified, and which had better inherent failure rates. Two candidates were identified - 1N4803B and JAN 1N5140A. Tests were conducted in circuit and both varactors passed easily. The JAN 1N5140A is the recommended replacement since its improved ratings and manufacturing quality control should reduce varactor failures by at least 94 percent. The JAN 1N5140A is stocked under NSN 5961-00-257-1688.

The 2N741A transistor was analyzed to determine replacement candidates. Although a number of candidates were found, subsequent tests showed that only marginal failure rate improvements might be obtained. The 2N2956 was the leading candidate identified which could successfully replace the 2N741A; however, the 2N2956 would yield only a 4-7-percent failure rate improvement, which is not significant. The primary problem with the 2N741A appears to be related to germanium junction characteristics under EMI-temperature stress; these same problems will exist to a greater or lesser extent with all germanium transistors including the 2N2956. The packaging constraints in the PRC-56 unfortunately eliminate the germanium transistors which have designs least susceptible to the stresses causing the higher

failure rate. The only practical solution is to change the transistor technology to a silicon base. Work performed under an independent task at the Naval Electronic Systems Test and Evaluation Detachment (NESTED) converted the AN/PRC-56 to silicon transistors. It is recommended that the NESTED improvements be incorporated in lieu of the germanium transistors evaluated by this effort.

MICROPHONE ASSEMBLY

The M-87 microphone, microphone cord, and mike boom collectively suffer a very high failure rate. Failures in the microphone are both electrical and mechanical. The electrical failures appear to be caused by humidity admitted through either cracks in the case or leaks around the element seal. The cracks in the case are simply incomplete mechanical failures. A leaky element seal is most probably caused by the tearing or loosening of the seal by wind pressure. In fact, the M-87 is susceptible to saturation by wind; in the saturated condition, the output drops by at least 50 percent and the noise-canceling characteristic virtually disappears (problem 2). Another possible type of electrical failure derives from shorts or insulation breakdown, or, in conjunction with other failures, welding of the dynamic windings due to intense electromagnetic fields encountered on the flight deck (up to 200 V/m); however, there are no data confirming or refuting these failure modes. In any case, the primary electrical failure mode is humidity entering through a leaky element seal. The mechanical failures are mostly cracked cases resulting from rough abuse. The mike boom is a two-piece wire loop assembly. The most frequent failures occur at a weld on the hinge between the two pieces or at one of the wire loops. Virtually all the documented failures resulted from users' attempting to bend the mike boom to place the microphone closer to the mouth. The foreboom (the loop connecting to the microphone) is not long enough to fit all users comfortably (see fig 4). The failures to the microphone cord were breaks in the wires at the connectors (usually at the microphone end), primarily in the cloth-covered versions (as opposed to rubber or plastic coated). There are some false replacements of the microphone and cord due to input transformer failures, but these probably constitute about 12 percent of the total replacements. Research revealed a microphone assembly in the National Stock System which is made up of the M-87 with a windscreen, a mike boom with a longer foreboom, and a rubber coated cord; the stock number is 5965-00-181-0213. The windscreen will protect the M-87 from wind saturation, the element seal from wind tearing, and the case from much of the normal abuse. Additionally, the windscreen reduces annoying speech artifacts from "p" and "s" sounds and helps the user to properly position the microphone for maximum output and intelligibility.

CABLE ASSEMBLY

The cable assembly between the electronics pods has a moderately high failure rate. Many of the failures occur in the ribbon cable where it enters the connector blocks. At this point, the cable is flexed across its width rather than in line; this puts a severe fatiguing strain on the cable. In order to relieve the strain, it is recommended that adhesive sealant RTV-102 be applied in accordance with figure 5 or 6. Although other failures occur within the connector blocks, the design precludes doing anything to correct this problem.

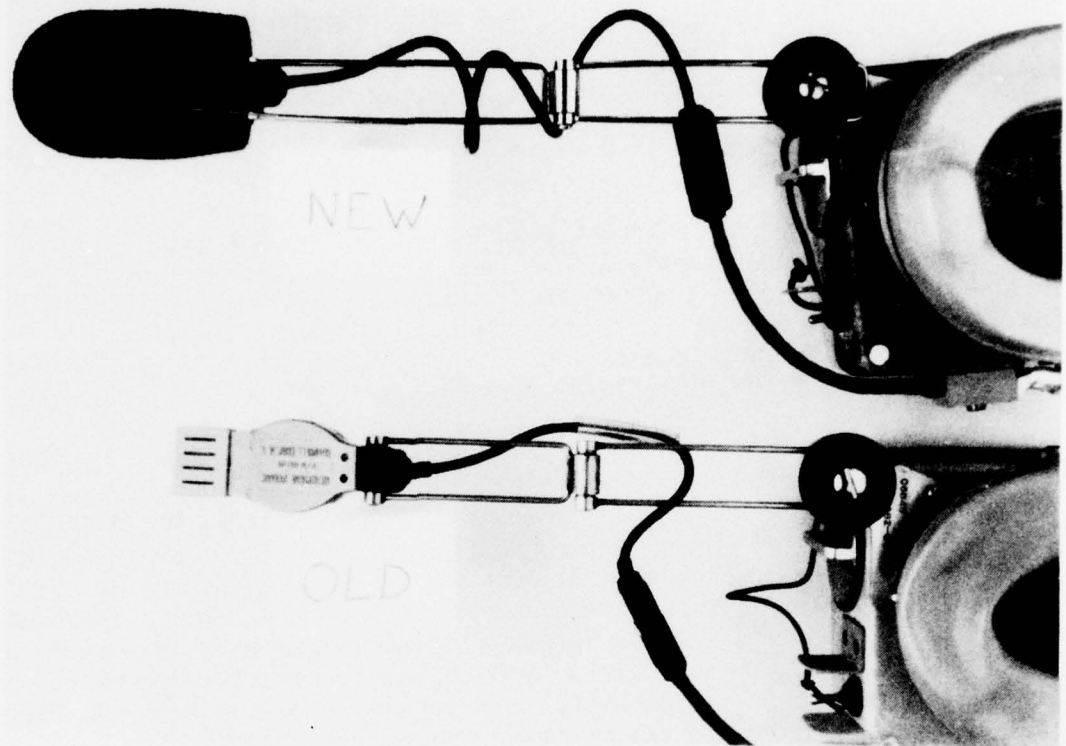


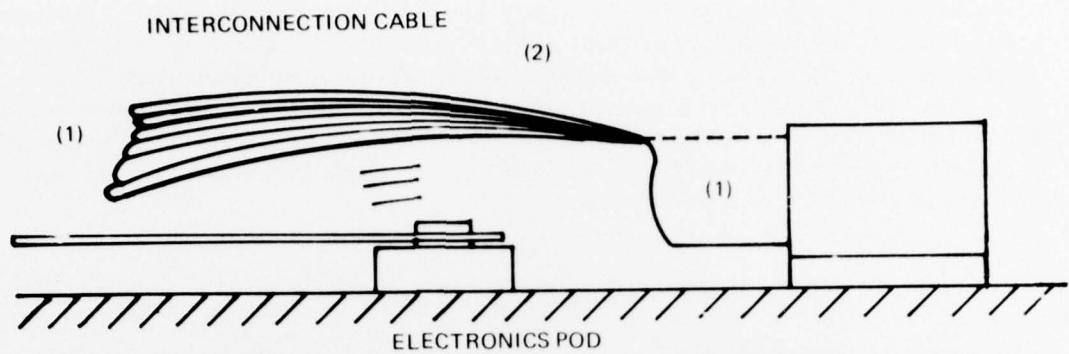
Figure 4. The old and new microphones, boom assemblies, and connecting cords. The new boom assembly has a longer foreboom. The connecting cord is wrapped around the boom to avoid snagging and to provide strain relief.

SUMMARY OF HIGH-FAILURE-RATE ITEMS

The above high-failure-rate items account for 50 percent of all corrective maintenance actions reported.

PC BOARDS

The printed circuit boards used in the PRC-56 have been shown to expand. The expansion loosens the feed-through grounds and causes intermittent contacts. Although ground connection is not lost, the intermittent contacts can detune the radio by altering the pattern of ground currents. Apparently the board expansion is caused by (1) the absorption of moisture, (2) the absorption of glycerine, and (3) aging. The board material is not particularly susceptible to moisture absorption when it is conformal coated, but frequent stripping of the coating for repairs and occasional omission of coating after repairs does contribute to the board swelling. Glycerine has been found inside a number of the pod assemblies and has been shown to contribute significantly to board swelling. The ear seals are the source of the glycerine.



- (1) FILL WITH RTV-102 (ADHESIVE SEALANT); DRY 24 HOURS (MIN) [1 WEEK PREFERRED]
 (2) COAT WITH RTV-102 FOR ABOUT 1 INCH (25mm) LENGTH INCLUDING PART OF THE CABLE TWIST

Figure 5. Application of adhesive sealant.

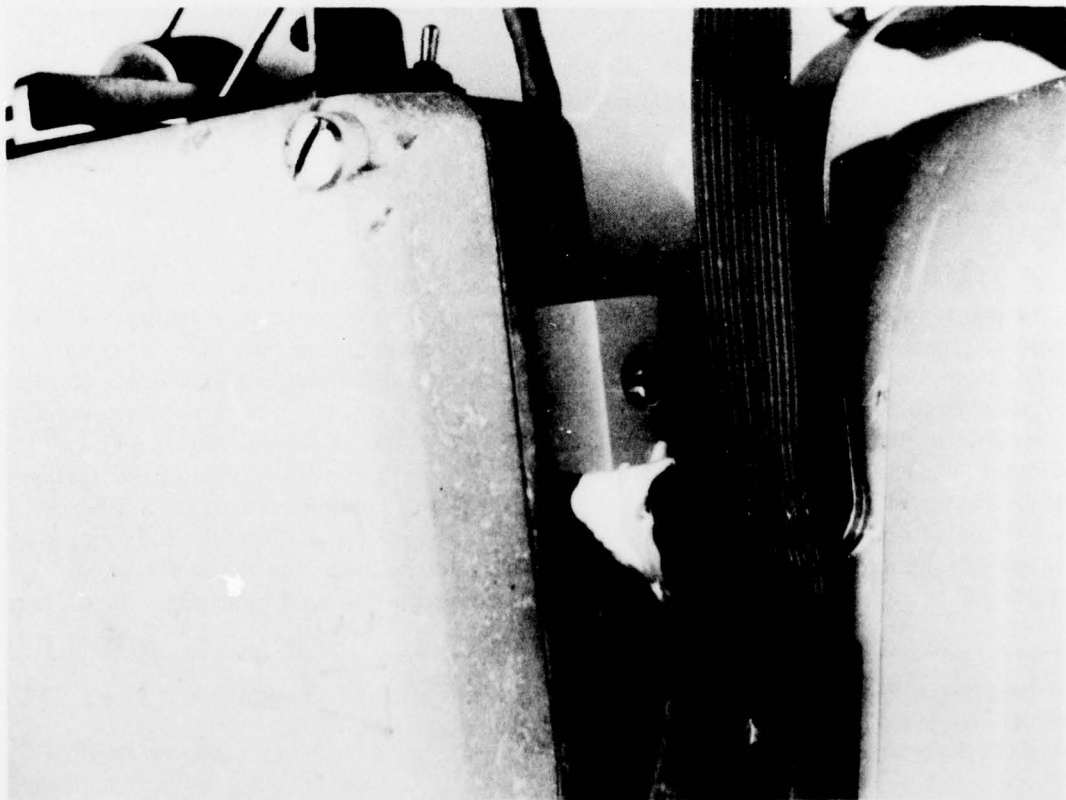


Figure 6. RTV-102 applied to a connecting cable to provide strain relief. Notice how the cable is held away from the pivot on the earpod.

The development of a new dry ear seal and the interim utilization of foam-filled ear seals where lower noise levels permit will greatly reduce this problem. The aging of the boards primarily affects solderability, the retention of the circuit foils, and the board material, which flakes and swells. When a board is deteriorating in this way, it should be replaced.

The board swelling problem deserves the attention of the fleet technicians because the electrical effects are so difficult to track down. It is recommended that the feed-through grounds be touched up with solder periodically to ensure that no intermittent contacts occur; this should especially be done on the transmitter.

ADJUSTMENTS AND ALIGNMENTS (Problems 3, 5, and 6)

SQUELCH ADJUSTMENT

The squelch adjustment is too critical to be a practical adjustment. A very small change in the variable resistor used for squelch adjustment results in a large change in squelch threshold. In some units, a 100-ohm change (1 percent) is sufficient (because of worst-case tolerance combinations) to go from the un-squelched condition to a squelched condition which cannot be broken in certain operating positions by normal signal strengths. With the current variable resistor, a 100-ohm change is effected in only 3 degrees of arc. Furthermore, the current variable resistor is easily knocked out of adjustment by impact shocks. The radical misadjustment of squelch can appear to be a failure in the audio, squelch, or noise-AVC modules, which often leads to the false removal of these modules. A 10-turn established reliability MIL-type variable resistor is recommended to replace the current part. The new part, RJR26FW103M, will be much simpler to adjust, since 100-ohm changes will now be effected in 36 degrees. The part is stocked under NSN 5905-01-012-3770. Figure 7 shows the existing and recommended replacement squelch controls.

TRANSMITTER/RECEIVER ALIGNMENTS

The PRC-56 is very susceptible to impact shocks and acoustic vibrations, especially in transmitter and receiver alignments. Fully 20 percent of all reported total failures (ref 4) are misalignments only and do not require a part replacement. Temporary losses of signal in certain deck locations also result from misalignments. Transmitter alignment requires 18 steps and receiver alignment requires 48 (ref 5). Considering both setting up to test and reassembling the radio, the alignment procedures require skilled maintenance manpower (often a Petty Officer First Class). A few of the adjustments are somewhat critical, but most of the misalignments are caused by the mechanical instability of the tuning components, especially the variable inductors. It is recommended that Teflon tape be used to stabilize the tuning slugs of the variable inductors. The tape will allow adjustments to be made, but the impact shock effects will become minimal. Figure 8 illustrates tape wrapped around a variable inductor core.

⁴ Material History Report, MSOD, Mechanicsburg, PA, 17055, Set hr. E06, Folder SS057, of 2 August 1976, MSOD 4790.S5704.C09, is Detailed Record of Completed Maintenance Actions

⁵ Flight Deck Communication System (AN/SRC-22(V)) Technical Manual; NAVELEX 0967-097-0010

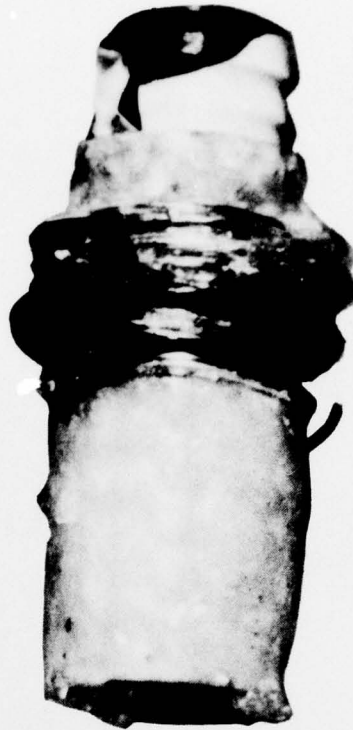


Figure 8. Tape wrapped tightly around the core of a variable inductor keeps the core from vibrating out of adjustment.

USER ACCEPTANCE (Problems 8, 9, and 10)

The PRC-56 rates high in user acceptance, judging from interviews of ship personnel. A large portion of this high acceptance relies strictly on the essential service provided by the FDCCS coupled with the fact that there is no alternative to date. The importance of the system to the user tends to mask the various problems which are irritating.

Most irritating is the presence of severe pressure points on the top and sides of the head resulting from the concentration of the entire weight of the transceiver onto the headband pad and the sagging of the electronics pods into the neck. The weight can be redistributed by snapping two headband pads from the H-157/AIC over the ends of the headband as shown in figure 9. These pads will distribute the weight sufficiently so that most users will not suffer excessive pressures. The pads are designated MX-2507/AIC and are available through the stock system under NSN 5965-00-715-6162 (less than \$0.90 each).

Another problem is the lack of a standby position for the earpods. A standby position relieves the pressure from around the ear during times of relative quiet. Ideally, the standby position would also allow enough space for the user to wipe off his ear with a towel without doffing the helmet. Unfortunately, the design of the helmet precludes a standby position short of doffing the helmet itself.

The two factors above plus a number of other minor helmet problems combine to create major problems of discomfort and irritating difficulties in the use of the helmet radio during operations. In some cases, an individual user is not aware of the irritation; however,

it is translated into physical abuse of the radio either inadvertently or overtly. The radios are tossed carelessly into a corner or slammed into a steel deck depending on the fatigue and irritation of the user. This fact directly contributes to an inordinately high unit replacement rate and to the need for frequent repairs. Two factors will enhance the user care of the radio: (1) improve its comfort and reduce the fatigue caused by it, and (2) make it a personally assigned item.



Figure 9. MX-2507/AIC pads installed to relieve pressure.

In order to make the PRC-56 a personally assigned item, it is necessary to have enough radios for all personnel plus additional spares to compensate for those being fixed. On a CV, this would require increasing the allowance from 32 to 39 and adding another battery charger. On a LPH, the existing complement of 16 is sufficient, but the allowance for a LPD should be increased from 8 to 10. These estimates are based on a study of operations in support of the Secure Man-on-the-Move Communications System (MOMCOMS) development (ref 6); the first increment of MOMCOMS will replace the FDCS in FY82. The maintenance requirements and unit replacement rate for LPHs is at most 25 percent that for CVs and LPDs, which demonstrates the benefits of personally assigned units. Fewer units should be required in

⁶Secure Man-on-the-Move Communication System (MOMCOMS), Volume II, NELC TD 219, 30 May 1975, JH Townsend and DC Gibson

procurement since the increased allowances should result in significantly lower replacement rates than the current replacement rates now experienced (approximately 40 percent per year—ref 7).

SIDE TONE

The PRC-56 does not currently have sidetone; however, if the recommendation to replace the push-to-talk switch with a pushbutton switch is followed, provision of sidetone will be inherent (see High Failure Rate Items—Switches). The effect of sidetone in high-level ambient acoustic noise is multifold. Sidetone provides confidence to the user that he is communicating, causes him to keep his vocal effort below the strain level, and slows down his speaking rate. These factors combine to reduce voice fatigue, which improves long-term intelligibility. In theory, the user is also aided in enunciation, thus improving intelligibility. Sidetone should be a welcome addition.

RECOMMENDATIONS

FOR SHIPBOARD ACTION

1. Most of the identified corrective actions can be accomplished easily as part of a field change. The proposed field change in appendix A is well within the capability of ship's forces. The field change includes new on/off and push-to-talk switches, a microphone with windscreen, a longer microphone boom, an improved squelch adjustment, improved-reliability parts, more-stable tuning, and sidetone.
2. Those users who are not subjected to the most intense noise levels (such as during catapult operations) should consider an interim replacement earseal (NSN 8475-00-940-9249) rather than the current glycerine-filled earphone cushion.
3. Those users who are bothered by a pressure point on the top of the head should install MX-2507/AIC headband pads over each end of the PRC-56 headband.

FOR DEPOT ACTION

1. Depot activities should note especially the replacement of the TNT356U01P18 capacitor by M39006/09-6469 and the PC-132 silicon varactor by JAN 1N5140A silicon varactor.
2. The 2N2398 transistors used in the RF front end should be screened to ensure a minimum beta of 30.

FOR NAVELEX ACTION

1. Approval of the proposed field change (appendix A) and associated engineering change proposals (appendix B) is recommended.

⁷Naval Electronic Systems Command Detachment, Mechanicsburg, PA letter 4043A:MJS:df1, 4400, Ser 3304-4043 of 10 September 1976

2. The procurement of the batteries for the AN/PRC-56/55 should be investigated and more stringent quality control provisions instituted to assure battery seal integrity. If necessary, a second source should be developed and the inclusion of newer battery technology into the cell construction should be supported. It is strongly felt by this investigator that a battery redesign is warranted and will result in greatly improved battery life with resultant cost savings.

3. The nonstandard parts now used in the AN/SRC-22 system should be reviewed and replaced with MIL-type parts wherever possible. This will improve both the reliability and logistics of the system.

4. The development of a new, nonfluid earseal (earphone cushion) with the acoustic and fit advantages of glycerine should be supported.

5. The findings of NESTED should be implemented, replacing the germanium transistors with silicon transistors.

6. The allowance for AN/PRC-56s should be increased to allow most users to be assigned a unit for personal use.

REFERENCES

1. Naval Safety Center Job Number 33054-BB of 14 December 1973, Machine Listing of Accidents/Incidents Having to Do with Air Operations Aboard Ships FY70-FY73.
2. DART Tracking Report 2, Maintenance Support Office, Mechanicsburg, PA, 17055, of 25 August 1975, MSOD4790S.3015.
3. Parts Report, MSOD, Mechanicsburg, PA, 17055, folder SS058 of 7 August 1976, MSOD4790.S6271-04.
4. Material History Report, MSOD, Mechanicsburg, PA, 17055, Set hr. E06, Folder SS057, of 2 August 1976, MSOD 4790.S5704.C09, is Detailed Record of Completed Maintenance Actions.
5. Flight Deck Communication System (AN/SRC-22(V))Technical Manual; NAVELEX 0967-097-0010.
6. Secure Man-on-the-Move Communication System (MOMCOMS), Volume II, NELC TD 219, 30 May 1975, JH Townsend and DC Gibson.
7. Naval Electronic Systems Command Detachment, Mechanicsburg, PA letter 4043A: MJS:df1, 4400, Ser 3304-4043 of 10 September 1976.

NOSC PHOTOGRAPHS

Figure	Negative
1	LSF 644-4-77
2	LSF 648-4-77
3	LSF 647-4-77
4	LSF 649-4-77
6	LSF 646-4-77
7	LSF 645-4-77
8	LSF 643-4-77
9	LSF 650-4-77

APPENDIX A: PUBLICATION ARTICLE (Proposed)

Field Change (1)—AN/PRC-56 Radio Set
Operational and Reliability Improvements; Type II, Class A
Routine Action: 1.5 Man-hours/Radio

This field change applies to the Radio Set AN/PRC-56, the helmet radio of the AN/SRC-22(V) Flight Deck Communication System. The purpose of this field change is to improve the reliability of the highest failure rate components, to reduce the total maintenance time per radio, to add sidetone, and to improve certain other operational features. Equipment nomenclature is not affected.

MATERIAL REQUIRED:

Item	Quantity	Description	NSN
1.	1	Microphone, boom, and cord assy	5965-00-181-0213
2.	1	RJR26FW103M resistor, variable, 10 turn, established reliability	5905-01-012-3770
3.	1	Switch, pushbutton, miniature, style M8805/64	5930-00-473-3386
4.	1	Boot, Dust and Water Seal, M5423/10-01	5930-00-950-4541
5.	1	Switch, toggle, spst MS 24655-241	5930-00-459-5387
6.	1 inch	Tape, Teflon	8030-00-875-9747
7.	1 oz	Epoxy	8040-00-061-8303
8.	.2 oz	RTV-102 (Dow Corning 732RTV)	8030-LL-111-5858
9.	1 inch	Masking tape	

(materials 6, 7, 8, and 9 come in quantities sufficient for approximately 16 field changes)

TOOLS REQUIRED

Soldering iron

Solder, 60/40

Screw drivers, pliers, etc, normally required for AN/PRC-56 maintenance

Drill and 1/4 inch drill bit

Test set for AN/SRC-22 (Bendix TS-100A)

File, flat, 1/2 inch

Knife, pocket

NOTE: Because of the drying times required, it is recommended that this field change be accomplished when the radio can be out of service for a day or more.

PROCEDURES

1. Remove the helmet assembly, ensure unit is off, remove battery.
2. Separate the electronics pods from the headband assembly, disconnect the interconnecting cable W3001.
3. Remove the back of the receiver pod and unfasten the receiver printed circuit board.
4. Remove the push-to-talk switch (S3002) and the switchguard tab. Lightly twist together the brown and white wire removed from terminal 3 and the green and white wire removed from terminal 2.

NOTE: It is recommended that steps 1 through 4 be accomplished on all equipments to be field changed and that step 5 be accomplished at the same time for all. Also, it is recommended that step 24 be accomplished at the same time for all units.

5. Mask the front of the mounting hole for S3002, mix the epoxy in accordance with the directions, and fill the hole flush to the inside of the case; allow to dry at least 2 hours.
6. Remove the back of the transmitter pod and unfasten the transmitter printed circuit board.
7. Remove the on/off switch (S3001) and the outside switch protection tab.
8. Install the toggle switch (MS 24655-241) with the terminals toward the outside of the pod (away from the ear defender side), using the switch boot from the old switch. It will probably be necessary to file the plastic block in the corner of the pod back to make space for the switch; a sharp knife will assist in cutting away excess material. The "on" position of the switch should correspond to the "on" mark on the inside switch protection tab. Solder the wires removed from the old switch to the new switch; the wire from the battery (red and white) should be connected to the top terminal.
9. Remove the microphone M-87, microphone cable (W3002), and mike boom by removing the bolt holding the boom swivel to the mounting plate.
10. Install the microphone with windscreen, boom, and cord assembly (item 1). Wrap the cord assembly around the boom 2½ times before plugging it into W3001.
11. On the receiver printed circuit board, locate the squelch control (R-151) and remove. The conformal coating over the leads should be removed in accordance with the technical manual procedures.
12. Install the RJR 26 FW 103M in the squelch control position. There should be a small gap beneath the new control and the printed circuit board. Reapply conformal coating in accordance with the technical manual.
13. Perform steps (a) through (d) for the following variable inductors:

T1 in the First Oscillator	(RCVR)
L40 in the First Mixer	(RCVR)
L60 in the First 23.5 MHz Amplifier	(RCVR)
T70 in the Second 23.5 MHz Amplifier	(RCVR)

T80 in the Second Oscillator	(RCVR)
T90 in the Second Mixer	(RCVR)
L6 in the Transmitter	(RCVR)

- a). Remove the tuning slug (count the turns required to back out the tuning slug to expedite returning).
- b). Cut a strip of Teflon tape 1/8 inch wide by the width of the tape.
- c). Wrap the tape tightly onto the tuning slug in a spiral in the same direction as the threads. Do not wrap the tape over itself. The tape should be stretched to conform to the slug.
- d). Replace the tuning slug.

NOTE: The epoxy applied in step 5 should be thoroughly dry before proceeding to the following steps.

CAUTION: Care must be taken to avoid damaging the radio with the drill.

14. Unfasten the transformer T3001 and capacitor C3001 assembly to avoid damage while drilling; DO NOT disconnect the leads to the assembly. Tape the assembly to the TB1 side of the case.
15. Remove the masking tape from the epoxy-filled hole.
16. Drill a 1/4 inch diameter hole 3/4 inch from the side of the case and 1/2 inch from the edge. This should center the hole over the "X" in "XMIT" and in line with the volume control. Finish the hole edges.
17. Install the pushbutton switch M8805/64 with the M5423/10-01 boot. Solder the blue and white wire (from terminal 4 of TB1) to the bottom terminal of the switch. Solder the two wires which were lightly twisted together in step 4 (brown and white from E6 on the receiver; green and white from terminal S of TB1) to the top terminal of the switch. Note that the receiver will now remain on when the push-to-talk switch is activated.
18. Replace the T3001/C3001 assembly.
19. Replace the receiver printed circuit board and the transmitter printed circuit boards into their respective pods.
20. Tune and align the receiver and transmitter in accordance with the technical manual.
21. Replace the pod covers and reconnect the headband assembly and the cable assembly W3001. Notice that there must be a 1/4 twist in W3001 in order to connect it to the electronics pods; ensure that only a 1/4 twist is employed and not a 3/4 twist which results from twisting the wrong direction.
22. Connect the microphone cord assembly W3002 to W3001 by lightly wrapping the excess length around the microphone boom 2-1/2 turns before plugging it in.
23. Lay the radio so that W3001 is on top and form the cable near each connector so that the cable is above the top of the connector and forms a 1/4 inch gap between the cable loop and the connector.

24. Ensure that the cable and connector are clean and dry. Apply RTV-102 to fill the gap between the cable and connector in accordance with the directions on the tube. Allow to cure at least 24 hours.
25. Reinstall the radio in the helmet assembly.

ROUTINE INSTRUCTIONS

1. Make corrections to the technical manual for the Flight Deck Communication System AN/SRC-22(V), NAVELEX 0967-097-0010, in accordance with the instructions below.
2. Personnel accomplishing this field change shall record its completion by submitting the appropriate Shipboard Maintenance Action Form in accordance with OPNAV 43P2 using Equipment Identification Code (EIC) QDIV.

TECHNICAL MANUAL CORRECTIONS

1. Figure 5-14, page 5-35, and Figure 5-22, page 5-51: add a line to the schematic of S-2 showing terminals 2 and 3 permanently wired together.
2. Figure 6-13, page 6-29: add a note directly under S2, "Terminals 2 and 3 are now Terminal 2 only."
3. Table 7-4, page 7-47, item number 10: delete all after "ELECTROLYTIC" and add "33 μ F, 10% tolerance, 15 Vdcw, MIL type M39006/09-6469."
4. Table 7-3, page 7-29, reference designation MK3001: change manufacturer's code from "82872" to "81134" and part number from "MC-87/A1C" to "693-8417 (M-87/A1C)."
5. Table 7-3, page 7-29, reference designation MP3002: delete all after "Rubber;" and add "MIL-type M5423/10-01."
6. Table 7-3, page 7-29, reference designation S3001: delete all after "TOGGLE;" and add "Spst; MIL-type MS24655-241."
7. Table 7-3, page 7-29, reference designation S3002: delete all after "SWITCH," and add "PUSHBUTTON, MOMENTARY: Spst, n.o., MIL-type M8805/64."
8. Table 7-3, page 7-32, reference designation R3351: delete all after "WIRE-WOUND," and add "10-turn, 10 kilohms, 0.5 W, MIL-type RJR26FW103M."
9. Table 7-3, page 7-13, reference designation CR1401: delete all after "10 pF" and add "65 Vdc, MIL-type JAN 1N5140A."
10. Table 7-3, page 7-30, reference designations CR3104 and CR3105: delete all after "silicon varactor" and add "10 pF, 65 Vdc, MIL-type JAN 1N5140A."
11. Table 7-3, page 7-39, reference designations CR4104 and CR4105: delete all after "silicon" and add "varactor, 10 pF, 65 Vdc, MIL-type JAN 1N5140A."

Record this action in the Record of Changes; in Table 1-11, page 1-21, "Field and Factory Changes;" and adjacent to each pen and ink correction by inserting this EIB number.

APPENDIX B: ECPs ASSOCIATED WITH RECOMMENDED FIELD CHANGE

MIL-STD-481A
18 October 1972

ENGINEERING CHANGE PROPOSAL (SHORT FORM) <small>(SEE MIL-STD-481 FOR INSTRUCTIONS)</small>		DATE PREPARED	ECP NO.	PROCURING ACTIVITY NO.		
ORIGINATOR NAME AND ADDRESS Naval Ocean Systems Center 271 Catalina Blvd, San Diego, CA 92152		2. MFR. CODE	3. CLASS OF ECP	4. JUST CODE	5. PRIORITY	
		55910				
6. SPECIFICATIONS AFFECTED			7. DRAWINGS AFFECTED			
MFR. CODE	SPECIFICATION/DOCUMENT NO.		MFR. CODE	NUMBER	REV.	
8. TITLE OF CHANGE			9. CONTRACT NO. & LINE ITEM			
Reliability and Operating Improvements						
10. CONFIGURATION ITEM NOMENCLATURE			11. IN PRODUCTION			
AN/PRC-56			<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO			
12. NAME OF PART OR LOWEST ASSEMBLY AFFECTED			13. PART NO. OR TYPE DESIGNATION			
14. DESCRIPTION OF CHANGE						
Parts replacements as follows:						
<u>Circuit Designation</u>	<u>Current Part</u>	<u>New Part</u>	<u>NSN of New Part</u>			
MK3001	M-87/A1C	693-8417 (81134)	5965-00-181-0213			
S3001	TSX-86 (04009)	MS24655-24 1	5930-00-459-5387			
S3002	TMX- 3 (04009)	M8805/64	5930-00-473-3386			
MP3002	N-5032B(97539)	M5423/10-01	5930-00-950-4541			
R3351	3329H-1-103 (80294)	RJR26FW103M	5905-01-012-3770			
Capacitor Item #10	TNT356U012P1B (37942)	M39006/09-6469	5910-00-010-8015			
<p>The above current items have been identified as high failure rate items in the AN/PRC-56; the recommended new parts are all of significantly better reliability. In addition, the new S3002 is easier to operate and will be wired to provide sidetone, a greatly desired feature. The new R3351 is a 10-turn vice 1-turn variable resistor which will make the critical squelch adjustment easier to accomplish and more rugged. The new MK3001 is the M-87/A1C with a windscreen which improves speech characteristics, prevents wind saturations, and protects the sensitive elements from damage.</p>						
16. EFFECT ON ASSOCIATED EQUIPMENT						
NONE						
17. PRODUCTION EFFECTIVITY BY SERIAL NO.			18. EFFECT ON PRODUCTION DELIVERY SCHEDULE			
ALL			N/A			
19. RECOMMENDED RETROFIT EFFECTIVITY			20. ESTIMATED KIT DELIVERY SCHEDULE			
FLEET			N/A			
21. ESTIMATED COSTS/SAVINGS						
Net savings \$10,000 annually plus 750 maintenance man-hours.						
22. SUBMITTING ACTIVITY AUTHORIZING SIGNATURE			TITLE			
23. APPROVAL/DISAPPROVAL						
GOVERNMENT ACTIVITY			SIGNATURE		DATE	

MIL-STD-481A
18 October 1972

ENGINEERING CHANGE PROPOSAL (SHORT FORM)
(SEE MIL-STD-481 FOR INSTRUCTIONS)

DATE PREPARED

ECP NO.

PROCURING ACTIVITY NO.

1. ORIGINATOR NAME AND ADDRESS Naval Ocean Systems Center 271 Catalina Blvd, San Diego, CA 92152		2. MFR. CODE 55910	3. CLASS OF ECP	4. JUST. CODE	5. PRIORITY
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6. SPECIFICATIONS AFFECTED		7. DRAWINGS AFFECTED		
MFR. CODE	SPECIFICATION/DOCUMENT NO.	MFR. CODE	NUMBER	REV.

8. TITLE OF CHANGE Reliability and Logistics Improvements	9. CONTRACT NO. & LINE ITEM
--	-----------------------------

10. CONFIGURATION ITEM NOMENCLATURE AN/SRC-22 Flight Deck Communication System	11. IN PRODUCTION <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO
---	--

12. NAME OF PART OR LOWEST ASSEMBLY AFFECTED CR1401, CR3104, CR3105, CR4104, CR4105	13. PART NO. OR TYPE DESIGNATION PC-132, PC-132A (01281)
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14. DESCRIPTION OF CHANGE
Replace PC-132 and PC-132A (NSN 5961-00-916-0661) silicon varactor diodes with JAN 1N5140A silicon varactor diodes (NSN 5961-00-257-1688) in the RT-647/SRC-22(v), AN/PRC-55 and AN/PRC-56.

15. NEED FOR CHANGE
The JAN 1N 5140A has a significantly better failure rate (estimated to be 15 times better, minimum) than the PC-132 or PC-132A and is readily available whereas the PC-132 is a proprietary device that is becoming difficult to obtain. Replacement is recommended as diodes fail in service. Better failure rate of JAN IN 5140A results from manufacturing quality control and higher P1V rating.

16. EFFECT ON ASSOCIATED EQUIPMENT

NONE

17. PRODUCTION EFFECTIVITY BY SERIAL NO. ALL	18. EFFECT ON PRODUCTION DELIVERY SCHEDULE N/A
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19. RECOMMENDED RETROFIT EFFECTIVITY FLEET	20. ESTIMATED KIT DELIVERY SCHEDULE N/A
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21. ESTIMATED COSTS/SAVINGS
\$400 annually (minimum)

22. SUBMITTING ACTIVITY AUTHORIZING SIGNATURE	TITLE
---	-------

23. APPROVAL / DISAPPROVAL

GOVERNMENT ACTIVITY	SIGNATURE	DATE
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