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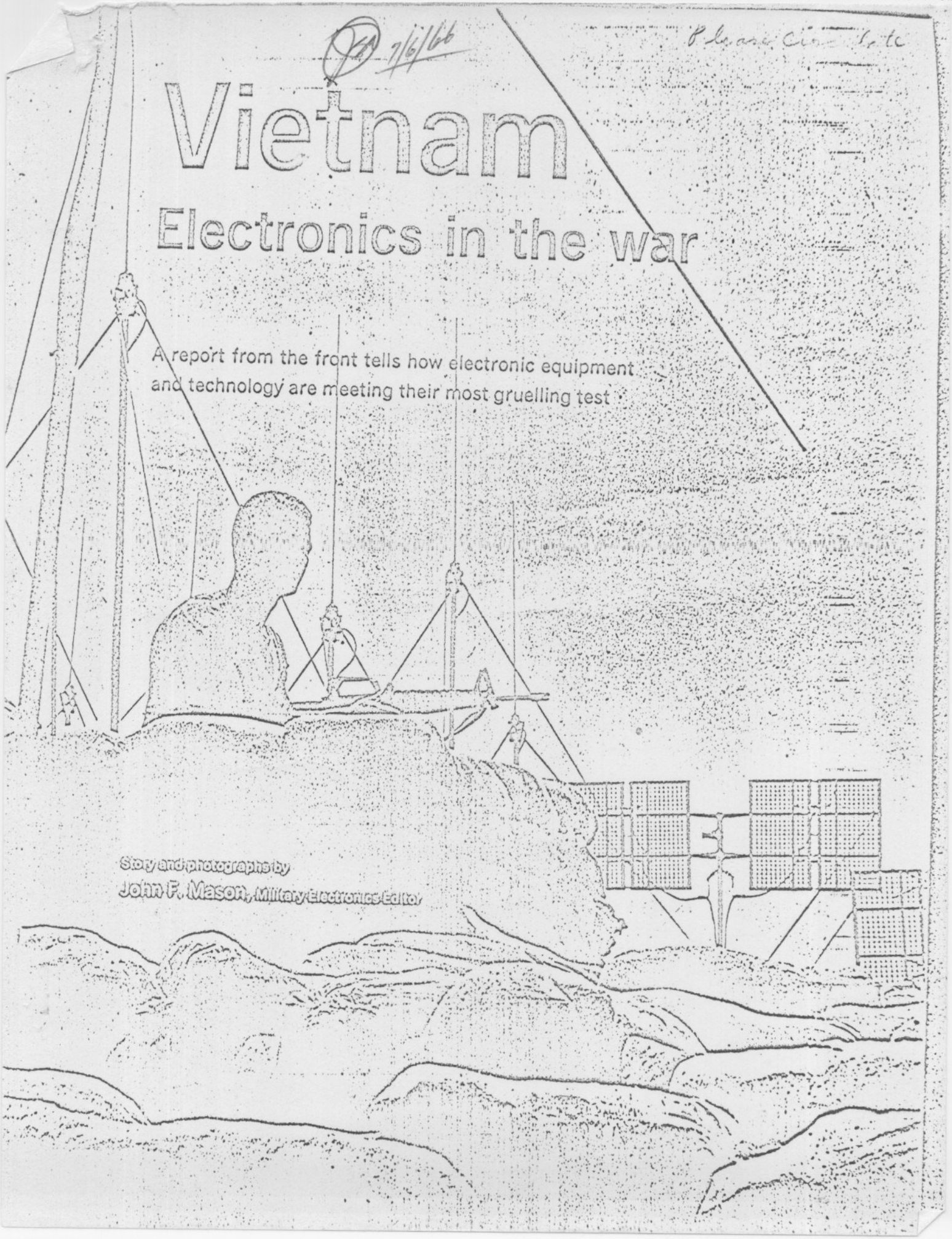
Vietnam

Electronics in the war

A report from the front tells how electronic equipment and technology are meeting their most gruelling test



Story and photographs by
John F. Mason, Military Electronics Editor

The war that needs electronics

From the huge backbone communications system that links all major bases to the radio of the lonely GI in a foxhole, electronics is in the war

"Electronics has never been so vital in a war as it is here in Vietnam." The speaker is Brig. Gen. Walter E. Lotz, assistant chief of staff for communications and electronics for the United States forces in South Vietnam.

"There are three big reasons for electronics' peculiar importance in this war," Lotz continues.

"First, you never know where the 'front' will appear—in a small hamlet, from a hole in the side of a hill, or on a path at night where farmers had carried straw and rice a few hours before. To watch every hole and tree in the country and be able to do something about enemy action when it takes place, you need a big, organized and complicated communications system. You have to blanket the whole country with communications."

As he speaks Lotz glances at a map on the wall of his office in Saigon that shows the major communications terminals in South Vietnam. Outside, a bulldozer is clearing ground for a new microwave antenna.

"The second reason for electronics' big role is the way this war is run," Lotz says. "Smaller decisions are made at higher levels than has been customary in previous wars." Tactical decisions that were made in the field in other wars are often made now by the Pentagon and even the White House. "To make an elaborate chain of command like this work, you have to have a fast communications system that can carry large quantities of data over long distances.

"Finally," Lotz continues, "is the need to know who the enemy is and where he is. We're trying to get electronic surveillance and identification devices to do this for us. This is very important."

Electronics in the war

To carry out its big role, what electronic equipment is being used in Southeast Asia? What kind of job is it doing? Where is it falling short? And how can industry make it better?

The answers are evident after looking at the equipment at the bases in South Vietnam and talking with the men who use and maintain it.

First, a big changeover is taking place. Permanent equipment is being installed in secure bases and the mobile gear is being moved to [illegible] areas. The result, however, is often bad. The two kinds of equipment don't work well together. Gen. Lotz says about this: "I hope industry will help us with this interface problem. It's not a short-term thing. In any war of this kind, the same transition can be expected. We will continue to need mobile gear. We will continue to need fixed installations and we'll need more and more interface, too."

Second, there are all kinds of equipment in South Vietnam and Thailand. Some of it is excellent and some is lousy. Some of it is old and some is new.

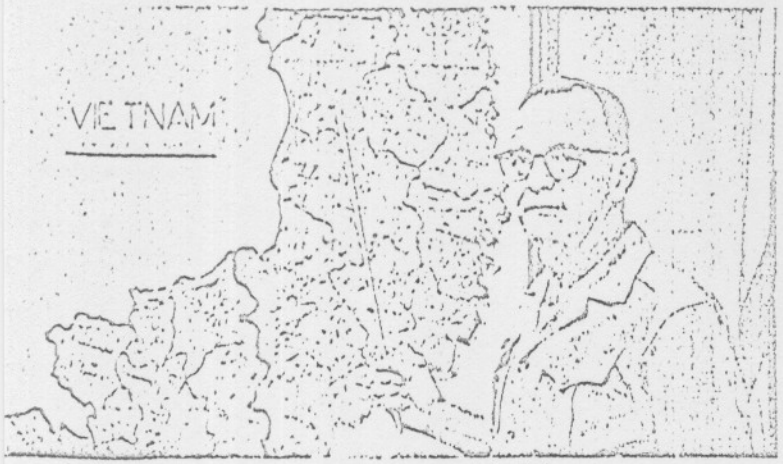
The advanced communications relay pods on aircraft, the balloon-mounted antennas and the inflatable sausage antenna masts are not in South Vietnam. Relay stations are carried in cargo planes, antennas are thrown into trees or extended on heavy metal poles.

The compact four-transceiver radio sets that would permit communications with any radio in South Vietnam are still somewhere in the U.S. Although some of the men say they don't even want a four-transceiver set, they would like a two-transceiver unit that would allow them to talk with both Air Force and Army aircraft. Now, they have to carry two or three individual sets.

Although much of the equipment in South Vietnam was broken in in South Korea, it still contains a surprising number of bugs. New gear, too, has design oversights. The antenna selection switch, for example, on the new AN/MRC-95 single-sideband radio corrodes and breaks off when it gets wet. The relatively new, high-frequency AN/PRC-47 radio that Forward Air Controllers (FAC's) carry on search missions is fastened to its case by a screw on the bottom; when it's put on wet ground, water seeps in the hole and the set stops operating.

Dust gets in everything, and little of the electronic equipment is built to withstand it. Environmental heat blows out transistors. Power generators fluctuate and tubes blow out.

Yet the AN/VRC-12 family of f-m radios "is superb," say the men who use and maintain it. So is Motorola, Inc.'s AN/TRC-87 five-channel, ultra-high-frequency, transistorized set, the Air Force says. "It holds the station, it is sensitive, and reception is excellent." And there are many other ex-



Brig. Gen. Walter E. Lotz commands the communications network covering South Vietnam and extending to Thailand and the United States. Over the next 12 months, the network's capacity will treble.

How the war is organized

There is a bewildering quantity of electronic equipment in South Vietnam and Thailand—much of it used by several services for different applications. From the standpoint of electronics, the war is divided into five operations:

- The backbone communications system; it ties together the bases in South Vietnam and in Thailand. This is a big, growing operation.
- Air support; a complex command and control network is needed to enable an Air Force Forward Air Controller in a tiny Cessna or an Army or Marine FAC on the ground to call for fire on a target from artillery, armed helicopters or jet fighter planes. Also, air defense; although it has never been used, there is a network of radars. Hawk missiles, interceptors and command and control centers.
- Mobile air traffic control units; there is doubt now whether the units need to be as mobile as they are.
- First Air Cavalry Division and Special Forces; the 1st Air Cavalry encompasses a large variety of forces—ground and helicopter-borne. They and the men who wear the green beret are heavily dependent on communications. Twelve Americans in an isolated camp, always in danger of being overrun by the Viet Cong, need every electronic trick they can get to keep in touch with help and to guide planes in during bad weather.
- Research and development; the peculiar environment of Southeast Asia requires certain on-the-spot research and development that can't be done anywhere else.

Communications

"When the big military buildup began in South Vietnam, the U. S. faced the biggest communications challenge ever presented the military services," says Lotz.

"Unlike South Korea, there was almost no communications here before we arrived. We had to build a system to serve the military, the American Embassy, the Vietnamese government and what we call the free world forces here—the Australians, South Koreans and New Zealanders." The problem was—and is—compounded by the Viet Cong and the Vietnamese topography and weather.

- The Viet Cong control many of the mountain tops suitable for microwave stations.
- High-frequency radio is plagued by the physical peculiarities of the area.
- Dust clogs equipment in the dry season; rain seeps in during the rainy season.
- The heat blows transistors and there is a continuing shortage of spare parts.

But the job has been done and a large amount of additional money will be poured into the system this year. "During the next 12 months," Lotz says, "we're going to treble the number of circuits we have now. This doesn't mean we'll put in three times as much equipment. We will install some new and bigger gear, but as much as possible, we'll try to improve receivers and make other modifications at terminals and relay stations to get more out of the system."

Backbone system

The main network that connects the major bases in Southeast Asia by the circuits in the map on page 98 is officially called the Integrated Wideband Communications System. This backbone network is made up of three kinds of equipment, Lotz explains.

The major portion is tropospheric scatter and reaches long distances over VC-held territory. The longest tropo link in the world is between Bangkok and Saigon—more than 450 statute miles. Reception, however, is not always dependable. New equipment is being installed to remedy this.

South of Saigon, where line-of-sight terrain is available, microwave is used. Where fewer channels are needed, there are radio relay towers. "This is actually tactical gear but it is used to tie the countrywide system together," Lotz says.

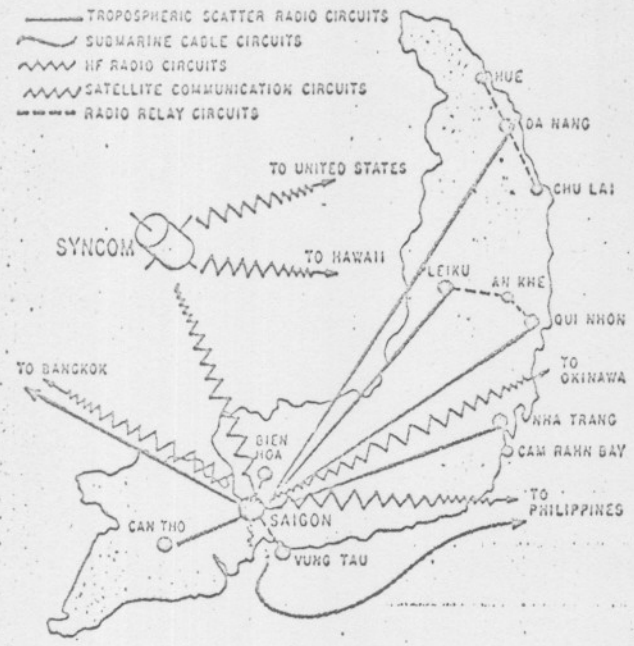
H-f radio is used to back up the tropo link with Bangkok and to communicate with Manila and Okinawa. The Syncom satellite is also used to communicate with Manila and with Honolulu. The main link with the mainland United States is a submarine cable installed by the Air Force about a year ago.

Management

The backbone network is managed by the Defense Communications Agency and operated by the four services. In South Vietnam, it is maintained by Page Communications Engineers, Inc., a subsidiary of Northrop Corp., and in Thailand by Philco Corp., a subsidiary of the Ford Motor Co. The defense agency and the four services in South Vietnam report to Lotz; in Thailand to Col. Albert Redman.

The design of each terminal is worked out by computer in the U. S. by Page Communications. Information fed into the computer includes the site location, distance to the next terminal, pro-

Backbone network



file of the terrain, power to be radiated, size and type of antenna, and the orientation of the antenna.

"Industry is providing us fast service now," Lotz says. "A year or so ago the lead time for big equipment like this was a year and a half. Now it's from six to nine months."

Troposcatter

Two kinds of tropo units are used in South Vietnam—the AN/MRC-98 parabolic antenna system built by Bendix Corp., which carries 60 channels, and the billboard reflector system, designated the AN/MRC-85, which carries 72 channels. It was built by a number of companies and integrated and maintained by Page Communications. Controls for both systems are contained in vans. In Thailand, the mainstay for tropo terminals is the fixed-based AN/LRC-3, built by Philco.

The MRC-85 installation at Pleiku is typical of tropo sites in South Vietnam. Under the 60-foot reflectors are long, air-conditioned vans that house the equipment.

In keeping with the changeover from mobile to fixed-plant sites all over South Vietnam, communications installations will become permanent. Foundations will be concrete instead of wheels, and buildings instead of vans will house the controls.

Page Communications is installing 120-foot-high reflectors in several places in South Vietnam. This will not double the number of channels, but it will provide more, and it will improve the quality of transmissions tremendously.

How do Lotz and his command feel about using civilians to maintain the equipment instead of military personnel? "We couldn't get along without them," Lotz says without reservation.

"That's another big electronics innovation in this jan, industry-employed electronics engineers are working right along with the soldier in battle. We have 300 to 400 electronics technical representatives now and we'll have twice that number in six months."

The systems control officer, 1st Lt. Willis E. House, at Pleiku, says they have almost no problems with the billboard reflector, the MCR-85. "It's one of the most dependable communications systems in South Vietnam," House says.

Page Communications technician Lew Wood, who has been at Pleiku for four months, says the main problem is trying to increase the threshold of a signal; to get more sensitivity out of the system. This calls for realigning the frequency selection circuits almost every night. "The temperature variation might cause this," Wood says. "Even the air conditioning varies in here."

The microwave communications system, designated AN/FRC-109, carries a maximum of 960 channels. The equipment was built by Lenkurt Electric Co. It operates for the most part south of Saigon, where the towers can be protected.

Thailand

The Pentagon still refuses to officially acknowledge that thousands of U. S. servicemen in Thailand are taking part in the Vietnam war. Yet, the mushrooming communications terminals, radar sites and air bases in the country stand as testimony to American presence there. And, many of the U. S. planes that bomb North Vietnam take off from Thailand.

To support this growing force and to coordinate it with the effort in South Vietnam, communications in Thailand and between the two countries will be more than trebled in the next year.

"We have 24 channels now," Col. Redman says. "We're going to 60 and in some places 120."

The AN/LRC-3 tropo equipment in Thailand is equipped with parabolic antennas that come in three sizes, 30, 40, and 60 feet in diameter. Frequencies are from 1,800 to 2,400 megahertz.

"Tropo will be enhanced by bigger reflectors, possibly twice as high as those now used." Redman continues. "Receivers will be improved and parametric amplifiers will be installed so we can pick up weaker signals. We'll also put in more microwave units," he says.

Redman says there are problems in the Thai network but some of them are being straightened out.

"Generators give poor performance," he says—a complaint that is a familiar lament all over South Vietnam as well as in Bangkok. "The generators are made by a number of companies; they are not standard and their performance is erratic. We need a family of generators. Commonality would be a very good thing here."

Redman's complaint highlights a difference in Thailand and South Vietnam. Redman wants standard equipment; in South Vietnam they would settle for equipment—any kind. High priority

In Thailand supplies move in with no problem.

"Teleprinter equipment is not standard," Redman continues. "None of it matched up at first. We had to beg, borrow and steal to get a working system. The Defense Communications Agency is standardizing the teleprinter equipment now but we still have about four different kinds of multiplexers.

"Besides these problems we don't have enough teleprinter equipment; it's one of the few things in short supply in Thailand."

According to Redman, one unit that works well in the field is the teletypewriter equipment made by Teletype Corp., a subsidiary of Western Electric Co. "It is rugged and stands up well in the field."

Some problems have been solved: "We had a lot of trouble with the rubber inflatable antenna on one mobile tropo system. Wind affected it, and keeping it inflated was a problem. We finally had to switch to a metal dish. Also, the system only had one transmitter. When we lost it, we lost 24 channels. We couldn't add another transmitter because the van was too small. Newer models, however, include a second transmitter."

Summing up the communications picture in Thailand, Redman says, "A lot of work is needed on tropo equipment. It works well up to 150 miles, but beyond that, reception is poor. Microwave works out well. We've had some good results with microwave on hilltops over distances of 100 miles. We use all the single sideband we can get—equipment by Collins Radio Co., the Radio Corp. of America, Japanese sets, anybody's."

Tactical systems

Besides the backbone system, each tactical unit in South Vietnam has its own communications system. When necessary the tactical system can be patched into the backbone network.

Although this probably would never be done, a Ranger crouched in a hole alongside a Viet Cong trail at night could talk on his AN/PRC-25 manpack radio to the Pentagon. He could communicate with his forward area base, which could then patch him in to the nearest backbone terminal. From there, his message could be relayed to Saigon and on to Washington.

In practice, operational headquarters patch into the backbone network to communicate with other commands, and to coordinate air strikes and other large-scale operations.

On target, on time

Gigantic air control system covers South Vietnam to handle hundreds of air strikes each day

A typical day in South Vietnam, March 29, 1966, dawns with the roar of American jets starting their missions to support the embattled ground forces, both by pounding enemy positions with rockets and bombs and by hauling in supplies. Before the day is over United States pilots will have attacked Viet Cong positions in 432 strike sorties, hitting troop concentrations, camps, fortified positions and river shipping. Air Force pilots will have flown 198 combat sorties, Marine pilots logged 155 and the Navy launched 79 from carriers. And there will be, in addition, hundreds of logistical missions.

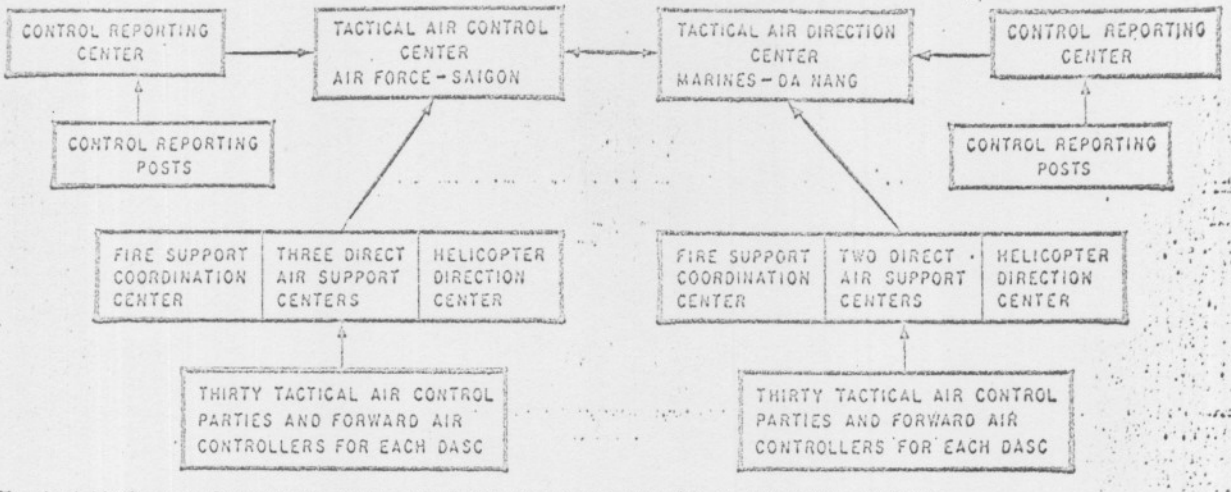
The system that controls all this is complicated but highly efficient. Constantly looking for targets are more than 150 Forward Air Controllers (FAC's). Army and Marine FAC's go out on foot, carrying manpack radios. First Air Cavalry Division FAC's go out in helicopters, and Air Force FAC's fly 01-E Cessnas. When a FAC spots a target, he radios his Tactical Air Control Party, a team that may have its radio equipment in a jeep or set up on a hill and operated by remote control from a safe, camouflaged place.

The Tactical Air Control Party then calls the next higher echelon—one of five Direct Air Support Centers (DASC) in South Vietnam, (shown in the chart, p. 100). Sitting beside each DASC are two advisory groups—a Fire Support Coordination Center (FSCC) and a Helicopter Direction Center. The Fire Support Coordination Center coordinates the request with other air, artillery and naval gun strikes that are scheduled. If the center clears the strike and helicopters are selected to do the job, the Helicopter Direction Center sends them out.

If fighters are decided upon, the Direct Air Support Center will try to locate fighters already airborne that can be diverted to the new target. If there aren't any, the DASC must go to the very top echelon—to the Tactical Air Control Center (TACC) operated by the Air Force in Saigon for the southern half of South Vietnam, or to the Tactical Air Direction Center (TADC) operated by the Marines in Da Nang for the northern part of South Vietnam. The Air Force or Marine center will order the fighter base or aircraft carrier closest to the target to dispatch fighters.

Once the strike planes take off, or those already

Air-strike coordinating network



Tactical Air Control Center, run by the Air Force, is top echelon for all air strike activity in the southern half of South Vietnam. Tactical Air Direction Center, operated by the Marines, is the equivalent for the northern part of South Vietnam. Under these are five Direct Air Support Centers, each aided by a Fire Support Coordination Center and a Helicopter Direction Center. Each DASC controls 30 or more Tactical Air Control Parties, including the Forward Air Controllers.

flying start toward the target, they are controlled by one of two Control Reporting Centers (CRC) in South Vietnam. One Control Reporting Center is near Da Nang for the northern part of the country and one is near Saigon for the southern end. These centers control air strikes by monitoring the plane from the time it takes off, through its strike until it returns to its home base.

When a plane takes off, a radar approach control center, Rapcon, located on the airbase gives instructions to the pilot to keep him clear of traffic and to get him safely to his mission altitude. About 30 minutes after take off, Rapcon hands the plane over to the CRC, which uses radars that are located along the length of South Vietnam and to the west into Thailand. The CRC monitors the flight to about 200 miles from the base where it is turned over to another radar, a smaller site called a Control Reporting Post.

The Control Reporting Center in the north reports the position and activity of all aircraft in its area to both the Marine's Tactical Air Direction Center in Da Nang and the Tactical Air Control Center in Saigon. In the south, the CRC reports only to Saigon.

The Control Reporting Centers and their subordinate Control Reporting Posts are the only units in the air strike network that use radar to monitor aircraft. Pilots report their positions verbally to the Direct Air Support Centers and to the Tactical Air Control Center in Saigon and the Tactical Air Direction Center in Da Nang.

Forward Air Controller

Radio equipment for the tiny 01-E Cessna is obviously vital for the success of its mission. The Air Force FAC in his plane is the only person who can tell and show the fighter pilots where to strike. After calling for the fighters, he waits for them to arrive, drops smoke bombs or flares on the target, and tells the fighter pilots what to do.

Without communications, a FAC in an 01-E is worthless. One morning, Lt. Col. Douglas Stewart took off from Tuy Hoa to lead a strike against some VC gun emplacements about 25 miles to the northwest. Stewart was half way there when he discovered his AN/ARC-45 ultrahigh-frequency radio wasn't working. Without uhf he couldn't contact the Navy fighters that were coming from the aircraft carrier U.S.S. Independence to meet him, so he had to turn back. Fortunately another plane with a good radio was standing by at Tuy Hoa. Stewart changed to it and made it back to the target in time.

But he isn't always so lucky. Stewart flies from seven to 10 missions a week and he says his radios fail on half of them. Stewart wants better reliability and he also would like more versatile equipment.

Besides the ARC-45 uhf radio, made by the Bendix Radio division of the Bendix Corp., the 01-E is equipped with two others—the AN/ARC-73, built by Collins Radio Co., a very high frequency set for talking with allied fighters used by the Koreans, Australians and New Zealanders; and the AN/ARC-44, built by Bendix, a frequency-modulated, vhf radio for talking with ground forces. All three radios are of Korean War vintage.

Because most U. S. fighters are equipped only with uhf, the ARC-45 is a critical radio for the 01-E. Some FAC pilots complain about the limitations of this set. It has 12 crystal-controlled channels, while the fighters have these as well as manually-tunable channels that cover the entire uhf band. When some of the 12 channels are busy or not operating, access to the fighter is limited. As the action increases in South Vietnam, several pilots say, 12 channels will not be enough. FAC's like to control the A-1 jet because it has a wealth of communications. It

Radios in South Vietnam

Military designation	Frequency (Mhz)		Modulation	Application
Airborne radios				
AN/ARC-44	vhf	24-52	f-m	Helicopters and other Army aircraft to talk with ground forces.
AN/ARC-45	uhf	220-340	a-m	01-E Cessna to talk with U. S. fighter planes.
AN/ARC-51	uhf	225-400	a-m	Replacing the ARC-55; also used with GCA and in TACP.
AN/ARC-52	uhf	225-400	a-m	Fighter planes to DASC.
AN/ARC-54	vhf	30-70	f-m	Helicopters to ground.
AN/ARC-55	uhf	225-400	a-m	Fighter planes to DASC.
AN/ARC-73	vhf	116-150	a-m	01-E to fighters.
AN/ARC-121	vhf	30-76	f-m	Airborne relay stations; consists of 3 VRC-49 sets.
AN/ARC-122	vhf	30-76	f-m	Command packages; consists of 2 VRC-46 sets.
Portable, man-carried radios				
AN/PRC-25	vhf	30-76	f-m	Manpack used by FAC's Pathfinders and patrols to ground base and helicopters.
AN/PRC-41	uhf	225-400	a-m	Manpack used by FAC to talk with fighter planes.
AN/PRC-47	h-f	2-12	a-m/ssb	Manpack used by FAC to talk with TACP's MRC-95.
AN/PRC-62	h-f	2-30	a-m/ssb	Manpack used by patrols to talk to unit headquarters
AN/PRC-64	h-f	2.5-6	a-m	Manpack, light weight.
AN/PRC-74	h-f	2-12	a-m/ssb	Special Forces "A" detachment.
HT-1	vhf	30-40	a-m	Patrols to talk with unit headquarters.
Ground-based radios				
AN/GRC-26	h-f	1.5-18	a-m	In 2½-ton trucks for long-range communications.
AN/GRC-48	uhf	226-400	a-m	DASC uses with aircraft ARC-52, ARC-53.
AN/GRC-109	h-f	3-24	a-m	Special Forces units with higher headquarters.
AN/GRC-125	vhf	30-76	f-m	Vehicular version of PRC-25 manpack.
AN/FRC-93	h-f	3.4-30	a-m/ssb	Special Forces camp.
KWM-2A	h-f	3.4-30	a-m/ssb	DASC uses with TACC and TACP.
Ground, transportable radios				
AN/TRC-24	uhf	50-100	f-m	Point-to-point relay interface on Hong Cong between cable and another TRC-24.
AN/TRC-27	shf	4,400-5,000	pulse position	Tactical set Marines use to Air Force CRC.
AN/TRC-32	uhf	225-400	a-m	CRC, ground/air.
AN/TRC-35	uhf	50-100	f-m	Radio terminal using the TRC-24.
AN/TRC-61	uhf	100-400	f-m	CRC, air/ground.
AN/TRC-75	h-f	2-30	a-m/ssb	CRC, DASC to ground stations.
AN/TRC-87	uhf	225-400	a-m	CRC, ground/air.
TR-20	vhf	30-40	a-m	Special Forces camp to talk with HT-1 on patrol.
Ground, vehicular-mounted radios				
AN/VRC-12	vhf	30-76	f-m	Jeeps, trucks, tanks talk with airborne ARC-54 and manpack PRC-25; used with GCA.
AN/VRC-46, AN/VRC-47, AN/VRC-48, AN/VRC-49	vhf	30-76	f-m	Variations of the VRC-12.
AN/VRC-24	vhf	30-76	f-m	Vehicular version of the PRC-25 manpack.
618T	h-f	2-30	a-m/ssb	TACP to talk with DASC and with division headquarters.
618M	vhf	118-136	a-m/ssb	TACP to talk with DASC and with division headquarters.

Although getting spare parts is a problem for almost all equipment in South Vietnam, there is a particular parts problem with the ARC-45. The radio, which uses a small, low-power transmitter, was originally built for the Army for limited use. When it was adapted for the 01-E, demands for the radio mushroomed so quickly there just weren't enough spare parts. Bendix is working overtime to produce more parts, but "get-well day" isn't expected before August.

ARC-45. When the fine red grit gets inside their tuning assemblies, it wears out the clutch that turns the variable capacitors. Sgt. Thomas F. Smith, who works on these radios, has thought about putting them in dust proof cans, but believes this would add weight and volume and delay repairs.

In Baltimore, where Bendix makes the radios, John Taylor, who worked on the first ARC-45 back in 1946, says the military has never told Bendix it was having trouble with dust.

be enclosed in a dustproof case, is affected much less by dust than the other two radios. All three radios are all-tube units, except for several transistors in the ARC-73's modulator.

It is no surprise that hits by small arms fire that don't harm the 01-E aircraft put its radios out of commission. Armor plating is an obvious answer but it weighs too much. FAC pilots would like another solution.

Air Cavalry FAC's

FAC's who go out in the Army UH-1D helicopter also use the ARC-44 radios. They have the same dust problem the 01-E pilots have. They say the two air coolers let the dust in, but they can't rebuild the set in the field.

One maintenance man in the Army's 1st Air Cavalry Division suggests that the ARC-44 doesn't have enough filters. It uses two paper throw-away filters, "but," he says, "in a place where supplies are so hard to come by, a good permanent filter that could be cleaned might be better." The problem is not insignificant. He points out, "When filters clog up, the radio heats up and components burn out."

The ARC-44 has an additional problem when it's used on the UH-1D helicopter. The f-m antenna coupler for the set is installed on the aircraft's tail pylon where vibration is so bad it causes the capacitors, which are held by wires 1/32-inch thick, to fall loose inside the coupler. When this happens, propagation drops off from the normal 15 to 20 miles to one mile or even less. This is serious since the ARC-44 is the only means a UH-1D pilot has to talk with his ground troops who are using the AN/PRC-25.

Specialist-5 Robert Schwerdtfeger, a senior avionics technician in the 1st Air Cavalry Division's 229th Assault Helicopter Battalion, says that building capacitors with heavier wires is not the solution to the problem since this would cut impedance and degrade the signal power and range. He says the antenna should be moved from the tail to the communications compartment in the front of the aircraft. Such a rewiring job, however, is too complicated to be done in the field. Another possibility, Schwerdtfeger says, would be to put cushions of some kind under the coupler to absorb the vibration.

A misfit

One radio in the UH-1D that Schwerdtfeger says should never have been used is the AN/ARC-54. "It's a good radio for bigger aircraft like the CH-47 or the Caribou CV-1, but not for this chopper. Everything goes wrong with it.

"The antenna coupler, as in the case of the ARC-44, is too far back on the tail pylon. It catches all the vibration. This not only affects the coupler but the antenna as well, since the cover for the coupler also serves as the base for the antenna.

"Vibration loosens up parts and allows dust to seep in. The two cycling reels which change position when the radio frequency is changed fail to function. Vibration also cracks circuit boards.

"If the coupler were mounted in the front of the aircraft it would help, but actually it just isn't rugged enough for the UH-1D to begin with," Schwerdtfeger says.

"The ARC-54 also has transceiver trouble," Schwerdtfeger says. "There is too much static in the transmitter and too much distortion in the receiver. Moisture, dust and vibration work together to cause this. They attack the modulator, which accommodates the voice pitch. When the modulator doesn't work, the voice is not intelligible.

"Dust also attacks the cycling drum which, when contaminated, continues to cycle rather than settling on a selected frequency. This problem could be partially solved by a better air filtering system. Sealing it wouldn't work because it would retain too much heat generated by the transmitter," Schwerdtfeger says.

"We have very little trouble with the ADF (automatic direction finder) but a lot of trouble with the J2 radio magnetic indicator. One reason for this is that we don't have facilities for calibrating it.

"The air speed indicator we use is not satisfactory because it doesn't show the direction the helicopter is moving—backwards, sideways or forward."

Marine FAC's

Marine and Army FAC's who go out on foot or in a jeep usually have three radios: an AN/PRC-41 uhf radio to talk with fighter aircraft, which is a backpack version of the vhf AN/VRC-24; an AN/PRC-47 h-f, a-m single-sideband manpack unit for talking with the jeep-mounted and more powerful h-f MRC-95 at home base; and an AN/PRC-25 vhf f-m radio for talking with helicopters and with their own Tactical Air Control Party (TACP).

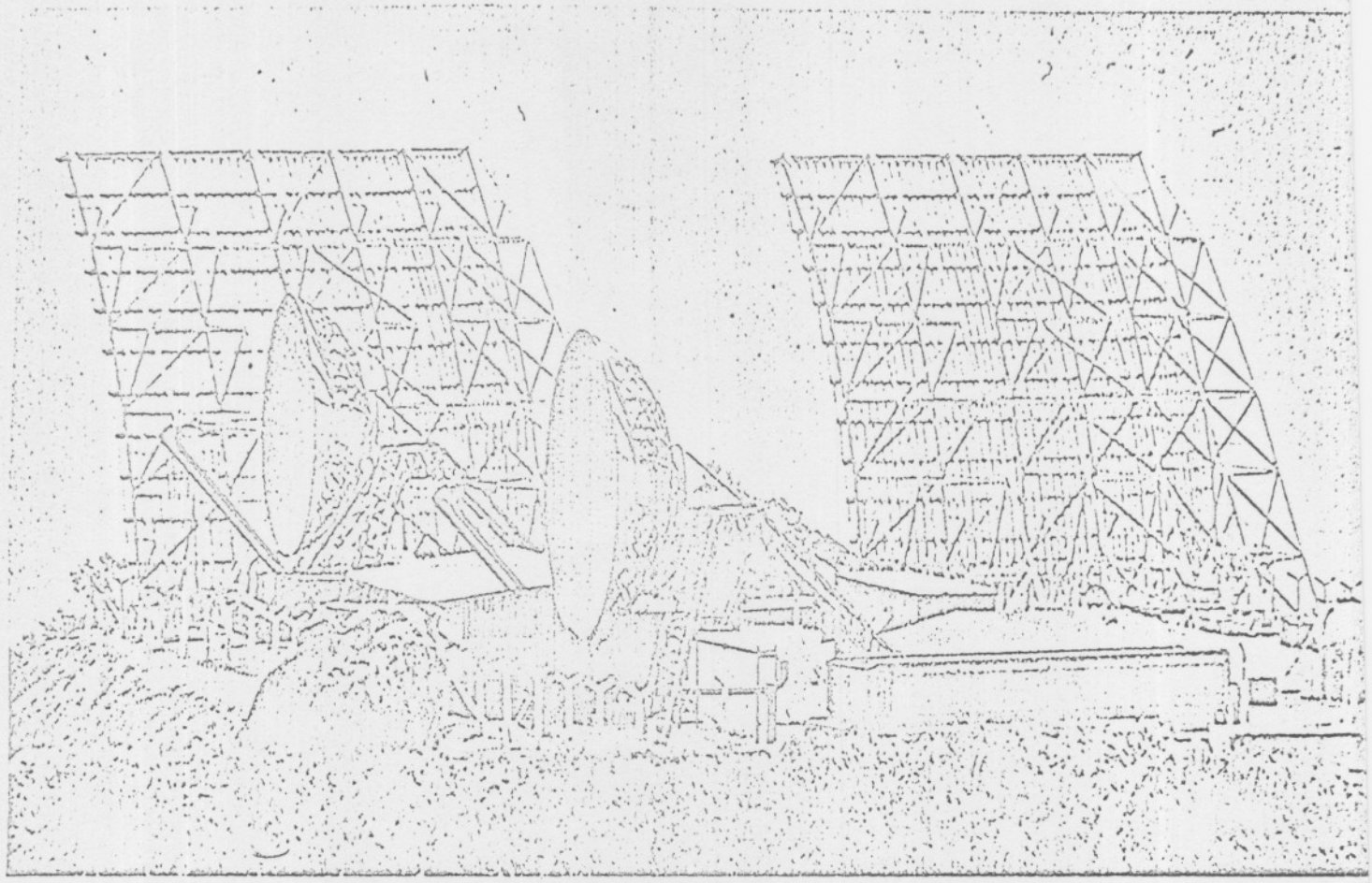
The PRC-47 has good power output, 100 watts, but it is heavy; with accessories it weighs 75 pounds and with its watertight case 175 pounds.

Chief Warrant Officer Yasutoyo Nagamini, electronics maintenance technician in the 1st Air Cavalry Division, who maintains equipment for airborne troops, has problems with the PRC-47. "The set is very vulnerable to water," Nagamini says. "One cup of water will put it out of commission. This might be remedied," he says "by changing the hold-down screws from the bottom of the case to the top. It's through this hole that water seeps through if the set is put on wet ground.

"Another problem is the short life of the wet silver zinc battery. It requires a specific electrolyte made only by the company that makes the battery, Gould National Batteries, Inc. Maintenance is difficult because special tools are required and the connection terminals break off easily."

The light, transistorized PRC-25 has many admirers and a few detractors. One complaint is that it's only fully compatible with another PRC-25. When two PRC-25's are used together a squelch circuit rejects weak signals below a set voltage,

Communications: tropospheric backbone network links command centers with . . .



Tropospheric scatter terminals, which beam communications channels hundreds of miles over Viet Cong territory, make up most of the backbone network in South Vietnam and Thailand. The parabolic antenna system is the AN/MRC-98, built by the Bendix Corp. Prime contractor for the 60-foot high reflector system is Page Communications Engineers, Inc. These mobile sites are rapidly being converted to fixed sites. Page already is building antennas 120 feet high.

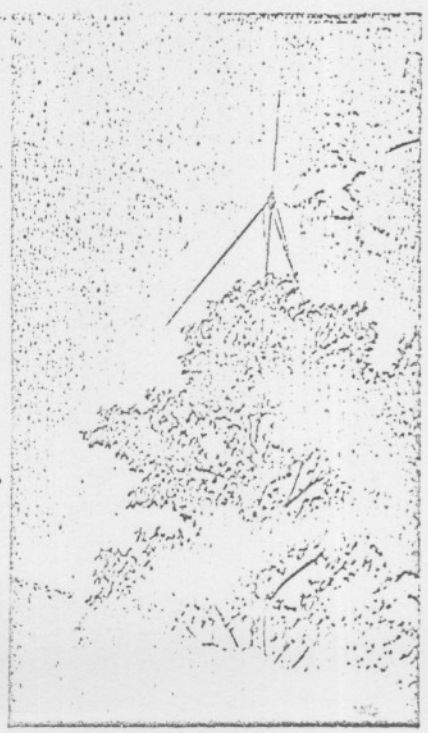
. . . tactical terminals in forward areas and aircraft control units

Forward posts talk with troops and ve- ... Air Force's Control Reporting Center, a fixed site that guides aircraft to targets

Forward units talk with headquarters via mountain-top relays and antennas in trees

The AN/VRC-12 family of vhf, f-m radios, which includes the VRC-46, VRC-47, VRC-48 and VRC-49 versions, communicates with the airborne ARC-54 and the man-carried PRC-25. The radios are light, transistorized and rugged.

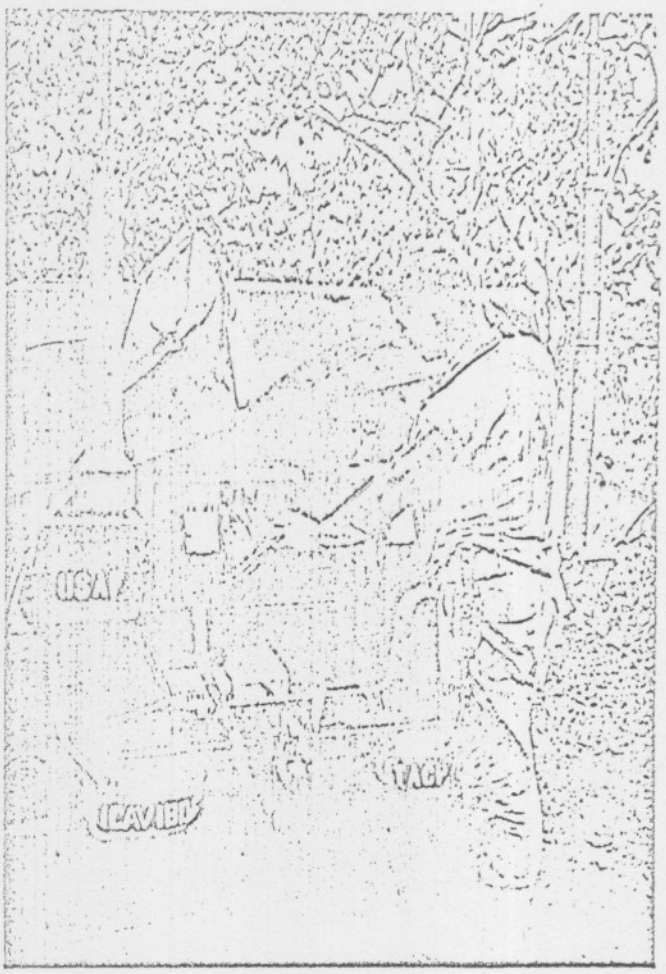
Top of mountain near An Khe serves as a radio relay station. AN/TRC-24 square antennas, left, pick up vhf signals



Tree tops serve as good masts for

Marines ask controller in jeep for strike; request is relayed to higher echelon

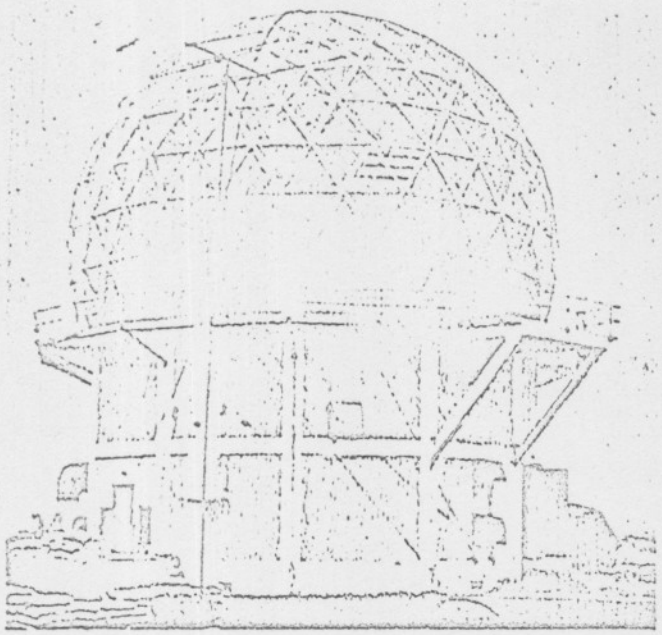
Two Marine Forward Air Controllers carry AN/PRC-47 h-f, a-m/ssb radio to report targets to their Tactical Air Control Party, set up in a jeep, like the Air Force TACP at right. FAC's also carry a PRC-25 vhf, f-m set to talk with helicopters and an AN/PRC-41 uhf set to communicate with Air Force planes.



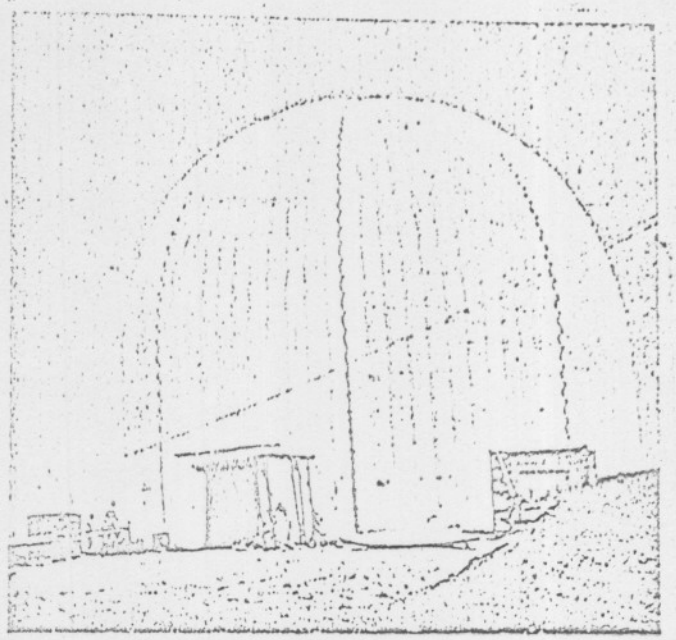
Tactical Air Control Party receives requests from Marine Forward Air Controllers (left) and Army FAC's, who are on foot, Air Force FAC's in 01-E Cessnas, and other FAC's in helicopters. The TACP forwards the request to the Direct Air Support Center (below).

Direct Air Support Center receives air strike requests from TACP (above right). The DASC can direct planes already airborne to the target or pass the request on to the Tactical Air Control Center in Saigon, or the Tactical Air Direction Center in Da Nang, to scramble fighters from a nearby airfield.

Big radars guide U.S. planes on air strikes and watch for enemy air attack



Control Reporting Center guides planes to ground targets and watches for enemy planes with Bendix Corp.'s AN/FPS-20 search radar.



Search and height-finder radar at Chu Lai backs up the CRC (left). The long-range AN/TPS-34 was built by Sperry Gyroscope Co., a division of Sperry Rand Corp.

Control Reporting Post, operated by the Marines at Chu Lai, could take over [illegible]

which eliminates much of the background noise. But when a PRC-25 operates with another radio, this squelch circuit isn't effective and the operators are subjected to the background noise.

Another dissenter says the PRC-25's power is not strong enough to key and hold the AN/VRC-49 relay package in the Caribou aircraft. "The Caribou has to get almost over the PRC-25 to pick it up—especially when the PRC-25 is in heavy vegetation," he claims.

The solution may be an amplifier Collins is developing, designated the RB-2. Collins developed one previously, the RB-1, but it didn't cover the PRC-25's entire spectrum and it amplified spurious radiations. The new amplifier will cover the whole spectrum and, it is hoped, will filter out the spurious signals.

Tactical Air Control Party

The FAC's report to a Tactical Air Control Party, called TACP, which has the same gear the FAC has plus additional equipment for talking to the next higher echelon, the Direct Air Support Center, DASC.

A typical TACP uses a jeep, equipped with a PRC-41, a PRC-47, a PRC-25, and an AN/MRC-87, which is a package containing an AN/ARC-55 uhf radio and an AN/TRC-75 h-f, a-m/ssb set.

In addition, most TACP's are getting some new equipment: a Collins' 618T, a h-f/ssb unit, which is used for long-range communications with the DASC and with the TACP's own home base, the division to which it is assigned.

A maintenance man at Nha Trang says there is trouble with the 618T: "Its power converter is often in the shop. The rectifiers break down and the 2N1523 transistors fail. This is caused by power fluctuation or a short in the transmitter caused by failure of the power amplifier tubes. When one transistor goes, they all go. Collins is working on this problem."

Another new Collins set the TACP's are using to talk with the DASC is a vhf unit called the 618M.

Direct Air Support Center

The DASC is a very busy place 24 hours a day. In a hut shaped like the top half of a large bubble, several dozen operators sit at desks with earphones and microphones, talking with pilots on air strikes in their area. In front of them are three status boards. One shows the position of friendly and enemy ground forces—the tactical situation—to help the operators direct air support to infantry troops. The second board shows the status of helicopter missions—these may be missions for logistical supply, troop lifts, medical evacuation or observation. The third board shows the status of fixed-wing planes, those providing close support with bombs, machine guns and 20-mm cannons.

One DASC function is to get fighter planes together with the helicopters they are to protect; get them on the right radio frequency and guide them to rendezvous. "Then we monitor their progress. When the mission is over we instruct them to take on a second mission or tell them to go home," a DASC operator says.

DASC operators use the GRC-48 uhf radio to talk with the fighter pilots. The fighters use the AN/ARC-52 uhf and ARC-55 uhf sets. A newer, solid-state radio, the AN/ARC-51, is gradually replacing the ARC-55. DASC communicates with other ground stations with the TRC-75, an h-f, a-m/ssb unit.

The DASC has a duplication of TACP equipment plus a Collins' KWM-2A, an h-f/ssb set with a 30L-1 linear amplifier. This set is used to contact the TACP's and the TACC in Saigon. It is compatible with the 618T h-f/ssb unit.

"Except for expected tube failure, the GRC-48 operates well," a top DASC official says. "It's one of the best uhf radios made."

Major Donald Quagliotti, at TADC headquarters says, "The blower motors on the TRC-75 give us a headache. We've burned up almost one a month. Of course, we operate 24 hours a day.

"Heat causes our driver tubes, designated 7289, to fail very often; also, our power tubes, 4X250B. If we had tubes that could last without air conditioning, we could avoid a lot of repair work."

The top command centers for air support in South Vietnam are the Tactical Air Control Center in Saigon, run by the 2nd Air Division of the Air Force, and the Tactical Air Direction Center in Da Nang, operated by the Marines. Both launch and control fighters and monitor every air strike and air movement in the country.

Like DASC, one echelon below them, these centers also work without radars. They monitor aircraft movement by verbal reports from pilots. The Air Force and Marine centers use the Defense Communications Agency's backbone system to communicate with each other.

Control Reporting Center

The Control Reporting Center is the unit that uses radar to control air strikes. In the northern part of the country, the CRC is on top of a mountain, and this affords it excellent radar coverage. The winding road up the mountain—one of the few good paved roads outside of Saigon—passes a big tropospheric communications terminal. At the terminal, two small mobile MRC-98 parabolic antennas sit alongside the gigantic 60-foot-high AN/MRC-85 billboard reflectors.

Communications from the busy CRC feeds right into this backbone network terminal for relay to any base in South Vietnam or Thailand.

The top of the mountain is a thick forest of antennas and radomes. The big FPS-20 search radar built by Bendix and the FPS-6 height-finder built by General Electric Co. both scan out to sea, into North Vietnam, as well as 200 miles or more into South Vietnam itself. The radars guide U.S. fighters to strike targets requested by FAC's. The FAC's request reaches the CRC via the long chain of command up to Da Nang's top echelon, the

Marines' Tactical Air Direction Center.

The large, active control room of the CRC is like an air-defense control center in the United States. There are rows of seats in raised tiers, with operators watching televised plan-position indicators of radar screens. Facing them in the center of the room is a large Plexiglas status board. Two technicians with headsets and grease pencils stand behind the board writing backwards the position of identified and unidentified planes that the operators call in.

The CRC monitors the plane from the time it takes off, to the target, and back to its base again. Every move is reported to the TADC in Da Nang and to the TACC in Saigon.

Elaborate CRC communications

For air-ground communications the Control Reporting Center uses Motorola Inc.'s AN/TRC-87, a new, solid state, uhf set that the communications officers like because of its good, sensitive reception, and the AN/TRC-88, a uhf, a-m radio.

Point-to-point radios include the AN/TSC-15 radio, an h-f, a-m/ssb transceiver that generates power up to 900 watts; the AN/TRC-61, a uhf, f-m radio; an AN/TRC-85, a uhf, f-m radio; the AN/MRC-62 radio relay; the AN/TRC-27, a super high frequency pulse-position-modulation set; and a Collins h-f, ssb KWM-2A.

The CRC, a permanent installation, has interface problems with tactical mobile equipment. One example of this interface "nightmare" has been the Marines' AN/TRC-27, a tactical point-to-point, transportable radio.

"It just doesn't work well with the Air Force's fixed-site equipment," complains Capt. Robert V. Carter, the CRC ground maintenance supervisor for communications, electronics and meteorology. Capt. Edward J. Erxleben, the squadron communications officer, echoes the statement. To communicate with the Marines, the Air Force, which operates the CRC, bought a TRC-27. But even the two mobile sets don't work well. When the antenna is moved by the wind—which is every few minutes—the beam is broken between transmitter and receiver. This cut-off—which is also the signal to indicate that someone is going to send a message—falsely alerts the operator as many as 20 times an hour. Motorola is working on equipment the Air Force believes will solve this problem.

"The biggest communications problem in Southeast Asia," Carter says, "is frequency interference. The spectrum is so crowded that only a digital system will solve it, and we don't have any."

There are other design problems. "All our uhf equipment specifications call for a 5-Mhz separation between channels," Erxleben says. "That is ridiculous. With the spectrum already crowded, we should have equipment with much better discrimination than 5-Mhz separation."

The Viet Cong also complicate the problem. "We're on a mountain top here and the VC are a few hundred yards away," Carter says. "We have to put everything close together. The way equip-

The leanest, fastest maintenance men in Vietnam

The Marines Air Tactical Control Unit that controls landings and take offs at the Marine airbase at Chu Lai is praised by some for its mobility and cursed by others for its limitations.

Mateu, as the air traffic control unit is called, has become a focal point for a new evaluation of the whole concept of mobility in limited war. Do you lose more than you gain by building systems that can be transported easily? And how necessary is mobility?

Those dubious about the value of mobility point out:

Mateu was built to be carried by helicopter, but it was taken to South Vietnam by ship. Also, while it can be set up in a few hours, who needs such quick reaction? Runways for jet planes don't just appear overnight. While the airfield is being built, a bigger, more versatile air traffic control system can also be moved in.

Proponents of air mobility agree that extreme mobility was not needed in the case of this airbase, but it might have been, had the site been farther from the sea. Access by land might easily have been denied by the Viet Cong.

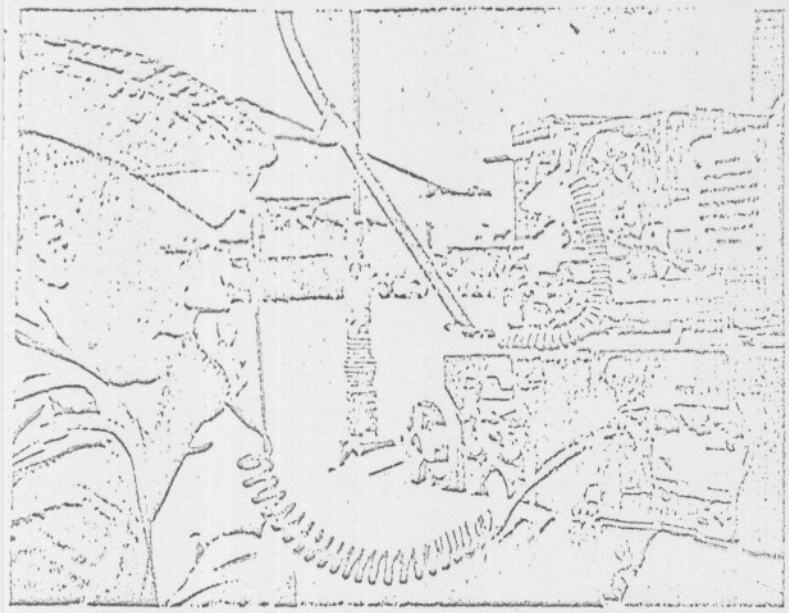
Marine Capt. John F. Keane, who is in charge of Mateu and extremely loyal to it, describes it:

Mateu consists of four 8-foot vans, two radars, and a tower —steel mat runways are on the ... The radars are the ... 125 for surveillance and a Ground Controlled Approach TPN-8 for landing when visibility is poor.

One van contains two surveillance radar indicators, radios, air conditioning and a place for the flight data supervisor. The GCA van contains two TPN-8 indicators, radios and Identification Friend or Foe (IFF) equipment. The third shelter is for supplies and the fourth is a maintenance shop.

The tower, which contains two consoles, rests on a 24-foot structure. Two additional shelters on the ground house the radio and recording equipment; their output is remoted to the tower. There are ultrahigh-frequency and very high frequency radios, direction finding equipment and controls for lighting. Two TPN-14 Tacan units are used for navi-

...though Capt. Keane is reluctant to criticize his system, he concedes it was not really designed for South Vietnam. Rain, sand, heat and humidity



Jeep-mounted Tactical Air Control Party relays a Forward Air Controller's request for a strike to higher echelon.

ment is designed, we get interference and cross talk. I wish some electronics genius would solve this one."

Erxleben is particularly concerned about the widespread need for remoting and the problems it entails. "We have too many cables. We've got wires running up and down the mountain side that are constantly being damaged by rock slides, corrosion, rats, Vietnamese wood cutters and the VC. Rats won't eat rubber, but they do go for plastic. Fortunately we have one plastic cable that's covered with another material that they don't eat. If we didn't have this, we'd have to stop the war."

Repairing these cables is more than just hard work, both men say. The mountain is steep, rock slides are common, much of it is mined to deter the Viet Cong from trying to overrun the installation, and the 'two-step krait' is prevalent—a small green snake so deadly the victim can only take two steps before he drops dead. There are also king cobras on the mountain slope. They are big and more easily spotted, but no less belligerent.

"Remoting by radio isn't the answer to the cable problems because this only uses more frequencies in an already crowded spectrum. Perhaps time-sharing cables is the answer.

"Another problem is the vulnerability of resin-filled splice cases to heat and rain. The resin won't adhere to the outer insulation of the cable because of moisture and temperature variation. Three days ago it was 108° and today it's 70°," Erxleben says.

Control Reporting Post

Backing up the CRC are several Control Reporting Posts (CRP). One at Chu Lai, operated by the Marines, was carved out of scrub brush and fine red sand that still plagues the millions of dollars of electronic equipment spread out over miles of what was recently wasteland.

The CRP operations room, which is a smaller

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reduce the life of servoactuators, bearings and all components. But he says new radomes that have been put on the radars should prolong their life.

Headaches with mobility

Back at headquarters, criticism is stronger. One officer says human engineering apparently had not been considered when the unit was designed. The vans are far too compact; people can't work efficiently in them. And the units are not self-contained.

"There's no reason in the world for putting spare parts for the entire system in a van all by itself," one major says. "When equipment fails in the Tacan van—which has to be 1,000 feet away from obstructions and electromagnetic radiation—the Tacan operator calls the maintenance man. The maintenance man runs 1,000 feet to see what's wrong, runs back to pick up a spare, and then back to the Tacan van to repair it. There's no reason why each van can't be a little bigger and have its own spares.

"The only result of the present set up," the exasperated major says, "is that we've got the leanest, fastest-running maintenance men in the Marine Corps."

The old less-mobile equipment, which the Marine company used in the United States, could handle three aircraft at a time. This one handles only two. The old unit had continuous search and precision tracking. This one provides either one or the other, not both.

Another drawback with this unit is that the equipment requires 45 minutes to warm up. If an aircraft wants to land when the equipment is shut down, it has to circle the field for 45 minutes while it warms up.

Help is on the way. New equipment is being developed. Two of the 8-foot shelters now in use will be replaced by three 20-foot vans. Besides more room, the new vans will contain approach and departure equipment—both of which are lacking in the Mateu now in use.

In Thailand, where the U. S. also has air bases, permanent air traffic control units are being installed. Already in use are mobile GCA landing systems, Tacan and VOR navigation aids, and a good vhf/uhf system for air-ground communications. Soon to be installed are Rapcon, a radar approach control system, and low-frequency beacons.

Both Thailand and South Vietnam are getting navigation systems, but not the same kind. Loran C is going into Thailand, while Decca is being installed in South Vietnam.

Vibration of the UH-1D helicopter causes capacitors to break loose in f-m antenna coupler for the ARC-44 radio.

version of the CRC's and could take over its job if necessary, is fed by an elaborate group of new radars—some spinning 360° to search for planes, others bobbing up and down to determine their height. Some are not enclosed but the two big ones are protected from the fierce heat and destructive dust by air conditioned radomes. They are balanced on the crest of the steaming hot, red-dust hill like giant balloons.

The radomes serve another purpose at Chu Lai. Viet Cong country is no more than 100 yards from the big radars and the radomes break the rifle shots of the snipers who come almost nightly for target practice.

One big radar is Westinghouse Electric Corp.'s TPS-22, a long-range surveillance radar, operating in the P-band, with a range in excess of 200 miles. The radar has only been up a couple of months, so it's too early to know what problems it will have.

A TPS-34 long-range, L-band search and height-finder radar, built by the Sperry Gyroscope Co., a subsidiary of Sperry Rand Corp., has been operating since Aug., 1965. Its only problem, according to Gerald E. Wightman, a Sperry field engineer, is that the heat has caused the radome seams to split. These are being reinforced with Neoprene fabric.

The site has three smaller L-band, medium-range search radars, designated the UPS-1 and built by the Radio Corp. of America.

Two other radars are the TPS-37, a medium-range, height-finder, built by the Crosley division of Avco Corp., and General Electric's MPS-11, which was to be replaced by the UPS-1. As usually happens the new radar was installed and the old radar was still needed. Both are still in operation.

Communications includes the AN/MRC-40 uhf, a-m radio for ground-air work, the AN/TRC-75 h-f, a-m/ssb for point-to-point, the MRC-62 and MRC-63 for f-m radio relay, and the AN/TSC-15 h-f/ssb—all were built by Collins. The site also has a TRD-12 uhf direction finder, built by Collins, and a TXQ-1 radar data relay from the UPS-1 to the center, which was built by the Raytheon Company.

Bombing with radar

One of the most effective tools used at the center—and one of the most mystifying to the Viet Cong—is the AN/TPQ-10 ground-based radar. The X-band radar, which was built by General Electric's Heavy Military Electronics department at Syracuse, N.Y., is so accurate, it can guide a fighter or helicopter over a target in zero-zero visibility and drop its bombs. It can guide a plane to a precise location and take a photograph. It can drop supplies in exactly the right spot day or night.

The entire job is done from the ground. Before the mission is flown, certain data is fed into the radar's computer: the target's coordinates, various aspects of the weather, ballistics of the bomb, and the altitude and velocity of the aircraft. The system can be hooked up with the aircraft's autopilot and bomb release device and the entire mission flown from the ground. This isn't done, however, because the pilots find it unnerving to feel their bombs drop away and the plane surge upward without warning. Usually, the radar operator talks the pilot through the operation. If the aircraft carries a beacon transponder, the range is 40 miles; without a beacon, it is 25 miles. The radar is so successful the other services in South Vietnam undoubtedly will order it soon.

Air defense

Although the air defense network in South Vietnam has never had to be used, an elaborate system exists. Command and control headquarters for air defense of all South Vietnam is the same Tactical Air Control Center near Saigon that handles air support. The same radar network throughout South Vietnam and Thailand that the Control Reporting Centers use to direct strike missions also scans the skies for enemy aircraft.

Radars in the network are the MPS-11 medium range search radar, the TPS-6 and TPS-40 height-finders, the FPS-20, for search, the FPS-89 height-finder, and the UPS-1 search.

Each radar site is self-sufficient with vhf and uhf radio for ground-air communications.

In addition to ground and shipboard radars there is an EC-121 aircraft called "Big Eye," equipped with search radar and operators.

Should there be an air attack, an Air Force major sitting in one corner of the CRC room near Da Nang or near Saigon could scramble interceptors to meet the incoming threat and order Hawk missile companies to fire at the enemy planes.

For want of a beacon a brigade moved out

An electronic beacon to show pilots the perimeters of friendly camps and where to strafe might have made a big search-and-destroy mission unnecessary

If helicopter pilots had had electronic devices enabling them to see the ground in bad weather there probably would have been no need for the large search-and-destroy mission that the 1st Airborne Brigade of the 1st Air Cavalry Division began on March 25.

With electronic homing beacons accurate enough to tell a pilot in zero-zero visibility that he was three feet outside the perimeter of a Special Forces camp and could safely strafe anything below him, the mission, called "Project Lincoln," would not have been so urgent.

But there are no such devices. Bad weather would start in the highlands of South Vietnam in a matter of days. And two regiments of Viet Cong were rumored to be waiting on the other side of the Cambodian border. When the rains began the VC would try to overrun the U. S. and South Vietnamese camps between Cambodia and Pleiku as they had done before. The Viet Cong know U. S. planes cannot provide effective ground support in bad weather.

One Special Forces camp, seven miles from the Cambodian border, called Duc Co was high on their list. Twelve American Special Forces men and several hundred Montagnards at Duc Co protect 13,000 Montagnard villagers and refugees from North Vietnam from VC attack.

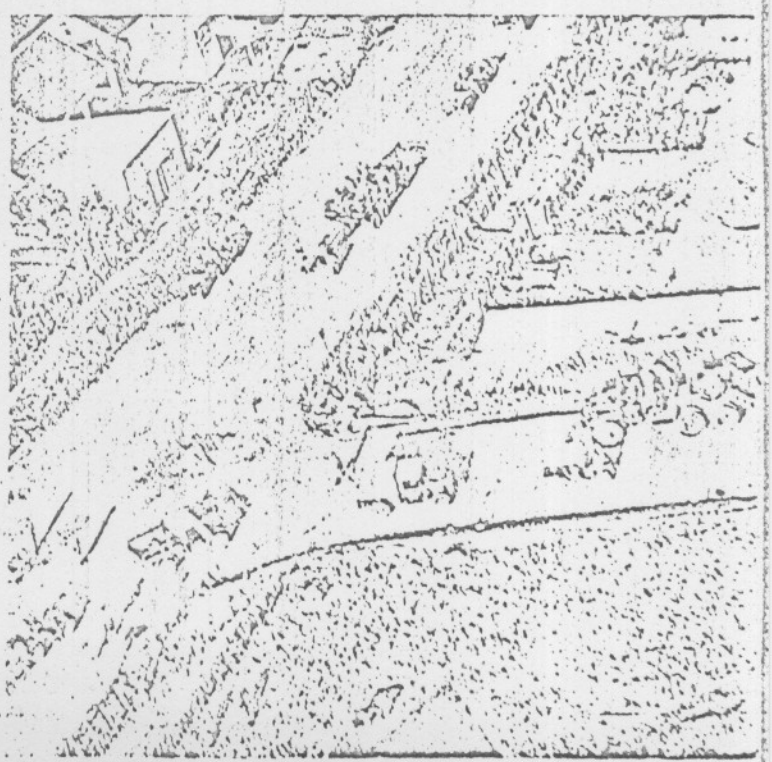
A heavy rain is falling outside Col. John J. Hennessey's window at An Khe as he describes the search-and-destroy mission the 1st Airborne Brigade, which he commands, will begin the next day. The rain will stop in a half hour and before night the mud will be dust again, clogging tuning assemblies in radios and other electronic gear.

"Tomorrow morning, we are going to open up new territory. We're going to move in, find and destroy all enemy forces in the area," Col. Hennessey says. The colonel makes an X mark on the map south of Pleiku. "Here we'll set up our forward area brigade headquarters. By convoy and helicopter—and by C-130 as far as Pleiku—we'll move in three infantry battalions, one artillery battalion, one air cavalry squadron, one tank company, one assault helicopter battalion, and the usual combat support—engineering and quartermaster. Division headquarters will be at Pleiku. There will be complete communications facilities at both headquarters.

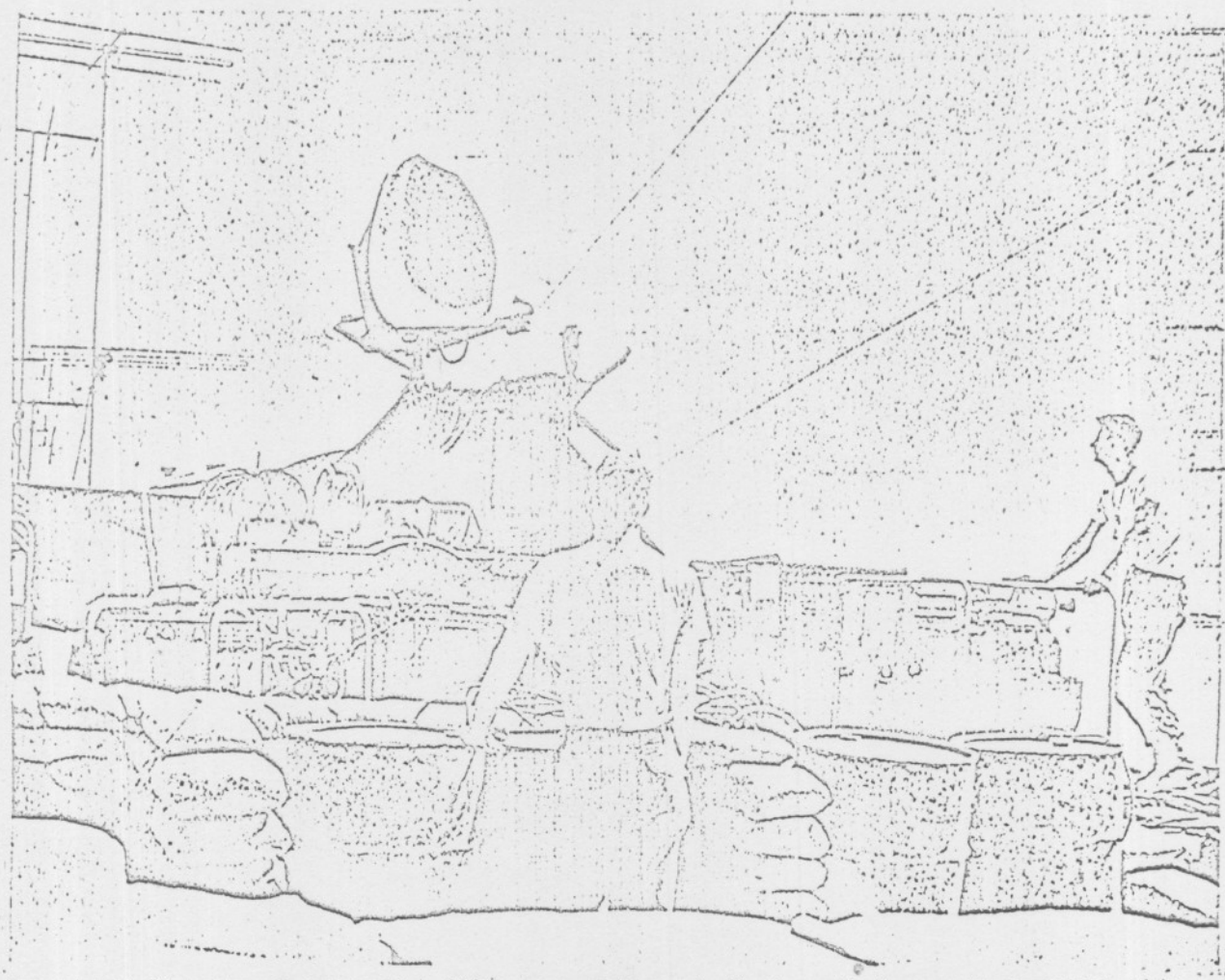
"From brigade headquarters we'll airlift two infantry battalions to two areas near the Cambodian border. They'll spread out and beat the bushes looking for VC, working their way back east to the forward area brigade headquarters. The first trucks should get to the forward area at 9 a.m."

Moving out

That night at An Khe, Mohawk reconnaissance planes with side-looking radar and infrared sensors begin taking off. They fly from dusk to dawn, to spot Viet Cong along the route the convoy will take before sunrise. Findings are radioed back. Artillery blasts 105-mm shells at some targets and



Whip antennas serve to tie together the 400 vehicles in the convoy as it moves out to a new forward area.



Ground controlled approach radar on this 800-foot mountain near An Khe is used in the surveillance mode to pick up aircraft 40 miles out. When the planes get close to An Khe's airstrip, the GCA there takes over.

UH-1D helicopters take off to knock out the rest.

By 07:05, C-130 cargo planes are taking off from An Khe's airstrip, carrying one infantry battalion to Pleiku; from there, trucks take the troops to the bare field that an hour or so later will become brigade headquarters with a full fledged communications network at its disposal. Later, other infantry troops are delivered directly to headquarters by UH-1D and Chinook helicopters.

When the convoy moves out from Pleiku, there are more than 400 vehicles stretching for miles along the road. It is evident the convoy is tied together by a good communications network. Every vehicle has at least one whip antenna rising from a bumper or the cab, even the giant tanks in the vanguard.

Ahead of the convoy at the Mang Yang pass, where more than 2,000 Frenchmen were ambushed and killed in 1954 by the Viet Minh, a predecessor to the Viet Cong, personnel detection radar was supposed to have been moved in by helicopter early that morning to watch for the Viet Cong.

It's an AN/PSS-[illegible] short-range radar that detects to 6,000 meters. When it picks up a target, there is an eerie sound on the operator's earphones.

But the radar is not there. Maintenance problems kept it at An Khe. Two days before, the maintenance man had been hoping to get the equipment ready in time by cannibalizing another set. There are no spare parts for it in South Vietnam.

Also slated for Project Lincoln was the AN/MPQ-4 mortar locator; it was to go along with the artillery. The MPQ-4, as well as the medium-range, personnel-detecting AN/TPS-33 radar, were also ailing; both from bad transformers. Because of the heat, five transformers had shorted out in the two radars and the only spare transformer at An Khe hadn't worked for weeks.

The TPS-33 is a medium-range radar that can detect people at 5,000 meters and vehicles at 18,000 meters. Presentation is both visual and audio.

Pathfinder

The pilot of the observation helicopter following the convoy hugs the ground a few feet above the

row mountain road and heads for a cloud of dust that hangs like fog over the new forward area.

The pilot switches on his very high frequency, frequency-modulated radio and a "pathfinder" team talks him to a landing spot. The team of two men and a AN/PRC-25 radio (see cover) had brought in aircraft all morning. They were big Sky Cranes carrying 500-gallon bladders of gasoline, Chinooks with infantry troops, armed UH-1D's and the small OH-13's.

The pathfinders like the PRC-25 but, they say, they would like industry to build another radio, too. They need the PRC-25's vhf/f-m channels, but they also need an ultrahigh-frequency set, tunable through 1,750 channels.

Pathfinders want the new set to weigh no more than 10 pounds including battery, operate continuously for at least 4 hours, and have an output of 5 watts. The new radio would relieve the crowded f-m band and also enable them to talk with Air Force planes. They say they don't need the four-transceiver AN/PRC-72; they only want two bands: vhf/f-m and uhf.

A number of quarter-ton jeeps and trailers are already operating in the communications area—a hill partially covered by trees a mile or so from the noise and dust of the helicopter site—and more radio vans are rolling in. Some of the equipment is "set up" simply by stopping the vehicle and turning the set on.

For sets that require the RC292 ground-plane counterpoise antennas, these are being put up on masts or in trees.

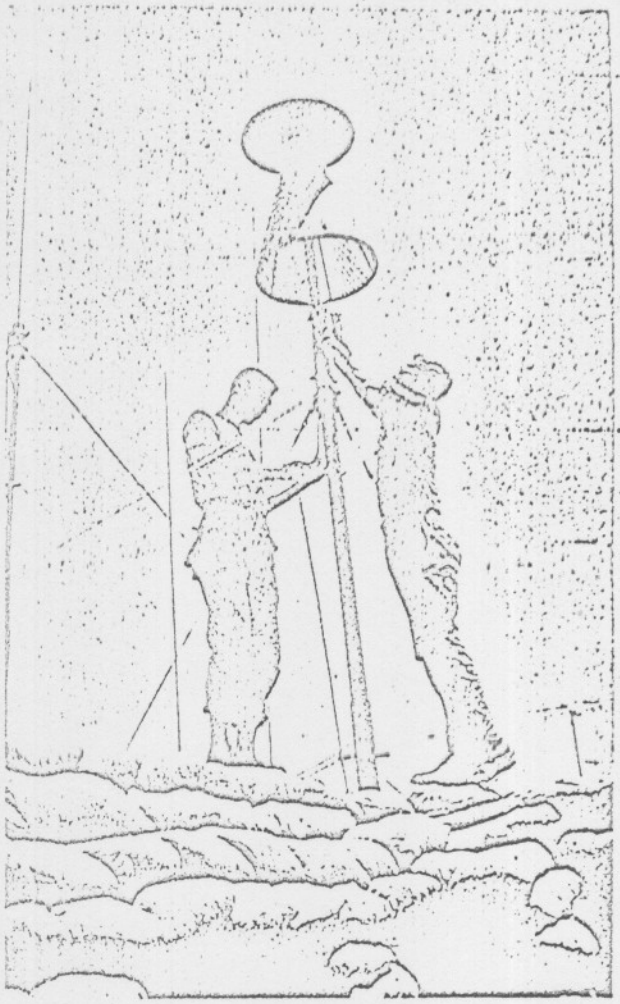
Although the RC292 serves its purpose well, 1st Cavalry communicators hope to replace it someday with a lighter, higher-gain, coaxial antenna that could be put up as high as 125 feet with no loss in decibels.

The mobile communications equipment is ready because of the good spade work done back at Fort Benning, Ga. by Col. Tom M. Nicholson and his men. Nicholson, now in Saigon, had been the Division Signal Officer at Benning when the 1st Air Cavalry Division was still the experimental 11th Air Assault Division. He and his men had repackaged, redesigned and installed almost all the electronic equipment on quarter-ton vehicles and trailers instead of the ¾- and 2½-ton trucks the Army customarily uses.

Mobility

A good example of Nicholson's work is the AN/MRC-111, a highly mobile, four-channel, vhf radio terminal, installed in a quarter-ton trailer in a horseshoe configuration.

Nicholson and his men had known back at Benning how they wanted the MRC-111 to be built. They had sent a diagram of the proposed configuration and a prototype they had built to the Army depot at Tobyhanna, Pa. To make sure the engineers at the depot didn't add unnecessary, heavy features, they sent a captain and an enlisted man who used the gear in the field. As a result, the MRC-111 came back on a quarter-ton vehicle rather than the 2½-ton truck its predecessor had required.



Viet Cong radios are easily monitored by special receivers on top of a mountain in South Vietnam.

The terminal's radio set, the AN/GRC-10, is bench-mounted on each side of the trailer. It operates between 54 megahertz and 70.9 Mhz with 170 channels spaced at 1-Mhz intervals. The antenna is a half-wave dipole with reflector and director elements.

The MRC-111 provides voice, multichannel, telephone, telegraph, facsimile or a combination of them all. Using 40-watt power the range is 20 to 50 miles—line-of-sight. Using 10 watts it reaches 5 to 15 miles.

One unit tried out at Benning and now a mainstay in South Vietnam is the AN/MRC-95 a-m/single sideband set built by Collins. Mounted on a quarter-ton jeep, the MRC-95 replaced the AN/GRC-26, which required a 2½-ton truck. Operating from 2 to 30 Mhz with continuous tuning at 1-Mhz increments, the MRC-95 proved its worth at Fort Benning and Santo Domingo. Nicholson's men at Benning were able to talk with aircraft on the ground in the Dominican Republic—a distance of more than 1,250 statute miles.

Chief Warrant Officer Yasutoyo Nagamini, elec-

tronics maintenance technician at An Khe, describes one problem with the MRC-95's antenna switch on the back bumper of the jeep that has been remedied in South Vietnam. The switch that selects the antenna—either a directional or a whip type—corrodes during the rainy season and breaks off. Since there are no spare parts in South Vietnam, the maintenance men built a switch cover, or latch, from galvanized aluminum. The cover protects the switch from rain and acts as an extension of the switch itself.

Nagamini says the only problem with the MRC-95 is one nasty little feature that causes it to be in the repair shop often. Power for the jeep-mounted MRC-95 is supplied by the jeep's battery or an external 3-kilowatt, 28-volt generator. If the radio is operating and someone starts the jeep's engine, a power surge blows all the transistors. This is true of the whole AN/VRC-12 family of radios. Solution? More training for the operators plus some kind of automatic cutoff.

Except when someone starts the jeep's motor without first switching off the radio, the VRC-12 family has provided "tremendous results," Nagamini says.

"There is a problem with the r-f connector" Nagamini continues, "that could be solved if we had spare parts. The connector isn't well protected. It gets bent and beat up easily. When it does, a major overhaul is required to repair it. The solution is a nut that protects the connector, but we don't have any. They have been on order for three months."

To give f-m, point-to-point radios greater range a CV-2 Caribou carries a relay package, the ARC-121, which consists of three VRC-49's.

When this relay package was put together at Benning there was an antenna problem. How could six whip antennas be mounted on one small aircraft? Standard instructions say f-m whip antennas must be 72 inches apart. There wasn't room for this luxury so Nicholson's men put them in the space they had available—sometimes as close together as 8 inches. The result was as good as if the antennas had been 72 inches apart. Another interesting discovery was that the position of the antenna didn't seem to affect the quality of operation. They pointed them straight up through the air vents in the U-6A plane. On the CV-2 they installed them pointing straight down. On the UH-1D they put them on the landing skids, horizontally. Performance was the same.

Mountain relay

Many of the radio vans going into operation on the hill at Project Lincoln's brigade headquarters south of Pleiku are aided by an elaborate array of electronic equipment crowded together on Hong Cong—a small flat mountain top 800 feet above the airfield at An Khe.

Rows of square, grid-like AN/TRC-24 reflectors on the edge of Hong Cong receive 12 f-m channels switchboard at 1st Air Cavalry Division headquarters at An Khe. From there, they are patched to individual addressees or to Qui Nhon where they enter the backbone tropospheric scatter network for relay to Saigon, and from Saigon to the U. S.

Low-frequency, f-m units on Hong Cong play a big role in Project Lincoln by relaying communications between the helicopter tower at An Khe and the helicopters taking off to carry troops and supplies to brigade headquarters. The station also relays communications from division headquarters at An Khe direct to ground stations at brigade headquarters.

A watch-dog radio on Hong Cong is also busy intercepting enemy radio messages.

A Ground Controlled Approach radar system, put together back at Benning by Major Egon J. Arndt and his staff, also is perched on the edge of Hong Cong, helping out Project Lincoln. Designed for landing aircraft when visibility is poor, this GCA radar is used in a surveillance mode to pick up helicopters and fixed-wing aircraft 40 miles away. It takes them toward the field at An Khe, and, when they are within range, hands them over to another Ground Controlled Approach radar system at the airstrip.

Each of these two GCA's and the other three the 1st Cavalry uses consists of a TPN-8 radar to provide the aircraft with surveillance and glide angle, three AN/ARC-51 or AN/ARC-55 uhf radios, two AN/VRC-46 f-m sets, and a vhf AN/ARC-73.

Last month, APX-44 transponders, made by Bendix, were installed in the 1st Cavalry's helicopters, increasing the range of the TPN-8 to 100 miles. The system, packagedeby Gilfillan, Inc., also identifies the plane the radar picks up by a Selective Identification Feature (SIF). Three bright lines appear on the radar scope under the aircraft's blip when the SIF interrogates the aircraft.

The TPN-8 is built with two scopes—one covers the full 360°; the other covers a smaller sector with more precision.

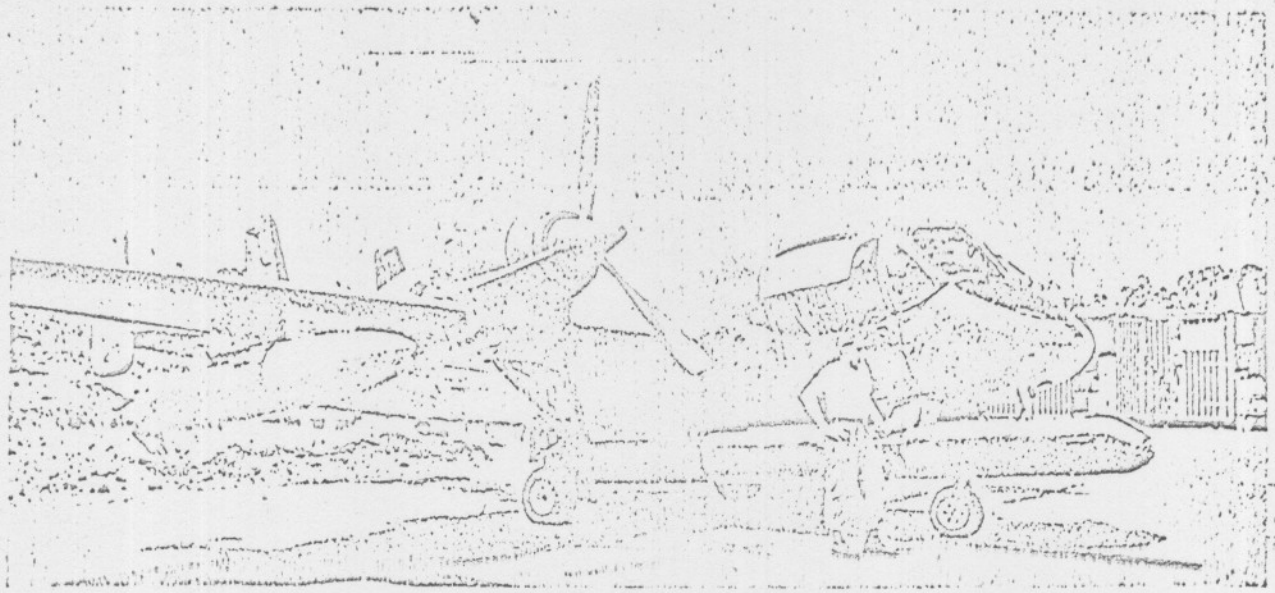
The entire GCA system weighs only 1,800 pounds; its trailer weighs 2,800 pounds, making a total of 4,600 pounds. Fixed installations often weigh 22,000 pounds.

After a runway is built at Project Lincoln's brigade headquarters, a GCA will be airlifted from An Khe and installed. The unit can be set up in 40 minutes.

The only problem with the unit, according to SP-5 Roger Crowley who operates it, is the power source for the ARC-55 radios. "It's a 28-volt radio and we have trouble drawing enough voltage and amperes. The radio overheats and blows the transmitter or receiver. This happens every five or six days. We need a better power source.

"The [illegible] radios are no problem," Crowley says. "The only trouble with the vhf is that being on top of a mountain we pick up too many signals."

The busy Hong Cong installation, accessible only by helicopter, is operated by 37 men, mainly



Mohawk surveillance planes equipped with side-looking radar comb convoy routes to find Viet Cong.

larger number of infantry troops.

The 1st Cavalry also has a lightweight homing beacon that has a digital coder and tuning system. Tridea, Inc., built the beacon to 1st Cavalry's specifications. The beacon is a low-frequency, building-block, modular set, with both 100- and 10-watt outputs. Frequency range is from 250 kilohertz to 510 khz. The 10-watt version weighs 26 pounds; the amplifier weighs 32 pounds. The range is 35 miles, unrestricted, with no blind spots.

The 1st Cavalry's helicopters use the ARC-55 uhf radio, the AN/ARC-44 vhf/f-m, the AN/ARN-59 l-f automatic direction finder (ADF), and the ARN-30 series of digitally-tuned, omnidirectional receivers. The helicopters have no navigation aids besides these direction finders and no station-keeping equipment.

Several replacements will be made soon: the ARC-55 by the newer, solid state AN/ARC-51; the ARC-44, with 280 channels, by the AN/ARC-54 with 800 channels; and within the next year or so, the ARN-30 by the newer AN/ARN-79.

Col. Hennessey's UH-1D helicopter and the aircraft of battalion commanders are equipped with a double airborne command package called the ARC-122. Mounted behind the pilot and copilot, the unit provides two consoles—each housing VRC-46 radios and three control stations. The entire package, including an array of four vhf/f-m antennas mounted on the skids of the helicopter, can be installed in the UH-1D in 20 minutes without any modifications to the craft. The system provides f-m voice transmission over two frequency bands: 30 Mhz to 52.95 Mhz, and 53 Mhz to 75.95 Mhz. Range is from 40 to 60 miles.

The colonel can talk with other aircraft and with infantry and artillery commands on the ground. Going into a landing zone he might monitor an artillery frequency and ask for more artillery. The ARC-122 was developed at Fort Benning.

Six Mohawk surveillance planes are assigned to Project Lincoln. Three are equipped with photographic camera systems and side-looking airborne radar (slar) and three with infrared sensors. They are stationed at Project Lincoln's forward area division headquarters at Pleiku. Both versions of the plane comb the area, reporting back suspicious changes in terrain features and any evidence of the Viet Cong.

The electronically-controlled photographic system, the KS-61, uses a KA-30 camera. Most adjustments are automatic: the exposure, the number of pictures per second, and compensation for image motion. The system works at night by using flares.

Motorola's side-looking radar, the APS-94A, requires only two minutes to produce a picture. The cathode ray tube of the radar is photographed and in two minutes the picture is developed and can be examined. In the future, this picture will be electronically-scanned and transmitted by data link back to the ground. The APS-94A reveals both moving and fixed targets. But it won't penetrate heavy thunderstorms.

ITRB-Singer, Inc., a subsidiary of the Singer Co., makes the infrared sensor for the Mohawk.

Readout from the infrared sensor is presented visually in the plane. The presentation is not photographed, but the information can be radioed verbally from the Mohawk back to the base.

Mohawks aren't just a "look and run" plane. Like the Air Force 01-E, the Mohawk drops flares on a target to show fighters where to strike.

Besides its sensors, the Mohawk has very sophisticated navigation equipment. The Collins ASN-33 integrated flight system displays altitude, true heading, and distance and bearing from the nearest l-f or VOR beacon. The system also integrates the information received from the instrument landing system—both the localizer and the glide slope. Coupled with the ASW-12 autopilot, the system

Special Forces lookout post holds up one end of the camp's only above-ground antenna—a 100-foot wire.

automatically holds a heading or follows a beam. It also works with the ASN-64 doppler navigator, built by Marconi, Ltd.

The Mohawk uses the AN/ARN-30E VOR receiver, the AN/ARN-59 ADF, the AN/ARN-22 radio altimeter, Bendix's AN/APX-44 Selective Identification Feature (SIF) transponder, the ARC-44 vhf/f-m and the ARC-55 uhf radios.

Special Forces at Duc Co

By noon, the communications for brigade headquarters of Project Lincoln are set up and functioning. Helicopters are transporting the infantry troops to the two landing zones near the Cambodian border, and the artillery battalion is in place, except for one company. That company, escorted by tanks, is on its way to Duc Co, a Special Forces camp seven miles from the Cambodian border where 12 American Special Forces men and several hundred Montagnards keep more than 13,000 Vietnamese refugees and local Montagnards secure from Viet Cong attack.

The only signs of communications in the drab, lonely-looking Special Forces camp are a telephone wire dropped from a lookout post built in a tall tree and a wire antenna about 100 feet long that stretches from the lookout post to a pole. A wire from the pole goes down to an underground bunker which houses the communications room.

Inside the communications room, a professional-looking communications console has been built from ammunition crates. It contains an AN/GRC-109, an a-m, continuous-wave unit that operates in the h-f band and has a power output of 15 watts. Messages are coded and, according to radio operator Sgt. Harold Palmer, transmission is excellent with Saigon, Pleiku and Nha Trang.

The GRC-109 is used by the "A" detachment, as the 12 men at Duc Co are called, to communicate with the echelon above them, the "B" detachment, which is in charge of several "A" detachments.

Only two antennas are used at Duc Co: the 100-foot wire stretched from the tree to the pole and another 100-foot wire that a few days before had been buried 12 inches deep, inside a 1-inch plastic tube. Results so far with the underground antenna are almost as good as with the one above ground, Palmer says.

"Our newest radio," he continues, "is the PRC-64. We've only had it a week." Transistorized, and weighing about 7½ pounds with battery, the PRC-64 is a long-range, h-f, single-sideband unit that can be used for voice and c-w code. "A doublet antenna cut to the right frequency is recommended for the PRC-64," Palmer says, "but so far we have used the 100-foot wire and got good results. We haven't tried voice on it yet."

A few days before, Major Anthony Scibilia, Group Signal Officer for Special Forces headquarters in Nha Trang, had said that the PRC-64 was doing "a fantastic job" in many green beret camps. Communications from 0 to 50 kilometers, he said, was questionable, but beyond 50 and up to 500 km it was excellent. The Delco Radio division of the General Motors Corp. built the set.

Another ssb set at Duc Co is the Collins KWM-2A, built for civilian use. "It's a very powerful radio. We can transmit and receive, loud and clear, on it anywhere in Vietnam," Palmer says.

"On patrol we take the HT-1 vhf radio made by the Hallicrafter Co. We use the TR-20 in the communications room for communicating with it. The HT-1 is not water proof, however, and actually isn't rugged enough. We also use the PRC-25."

When it's almost dark at Duc Co, Special Forces Sgt. Stevens comes in the communications room and picks up a PRC-25 radio. He and 10 Montagnards are going down to a refugee village and sleep by a trail that night. They suspect Viet Cong infiltration into the village from across the Cambodian border. If Stevens should discover a big concentration of VC, he will call in on his PRC-25 to Sgt. Palmer and on the same set summon helicopters from Project Lincoln.

According to Major Scibilia, other "A" detachments have additional radio equipment. Some use the PRC-74, made by Hughes Aircraft Co., an upper side band, h-f (2 to 12 Mhz) voice and c-w set, formerly called the HC-162D. Although it's transistorized, Scibilia says it is still too heavy; it

weighs more than 30 pounds with its wet cell battery. "We need a radio with a dry cell battery like the one in the PRC-25."

Another radio is the FRC-93, an h-f/ssb (2 to 30 Mhz) voice and c-w set with 200 watts peak envelop power.

"We need a small, air-ground radio with two-way voice communications, a long-life battery, and a homing signal that is silent around the sender for a radius of 10 yards," Scibilia says.

"We're now using the URC-11 but it consists of two pieces of equipment; one is the transceiver and the other is a battery case. They are connected by an 18-inch cord."

The "B" detachment uses the same equipment the "A" detachment does plus a GRC-26.

All night, every five minutes, the artillery company that had set up that afternoon just outside Duc Co's perimeter fires 105-mm shells.

Had they brought the MPQ-4 mortar locator radar that the men at An Khe had been trying to repair two days before?

"No," one major says, "but it's just as well. It only runs for five or ten minutes at a time and then breaks down. And when it does work it only scans 22½°. Here in South Vietnam we need a radar to look for mortars in every direction—360°."

For targets, the company is completely dependent on surveillance teams in aircraft or from infantry strikers on the ground who call in the target coordinates by radio. In the operations tent there are several radios in the VRC-12 family and the MRC-95. Outside RC292 ground-plane counterpoise antennas tower above the small village of brand new half tents, no more than 2½ feet high, that had sprung up that afternoon.

In a village near Duc Co, Sgt. Stevens and the 10 Montagnards are finishing a breakfast of boiled rice. The night was uneventful, he says. He hadn't even called in on his PRC-25.

Traveling by ¾-ton truck from Duc Co to the village takes about 25 minutes along a narrow dirt road with brush high on either side. Ambush is a constant threat. Two Montagnard strikers in the truck sit with their rifles ready, but a Viet Cong always shoots before he is seen. Picking off an American brings a good prize.

Research and development on detecting an ambush is under way in Saigon and Bangkok.

Project Lincoln will go on for many weeks. Because of it, perhaps Duc Co won't be overrun by the Viet Cong. An electronic beacon to define the perimeter of the base to a pilot in bad weather might have made the entire operation unnecessary.

War brings on-the-spot research

Military services are working on research and development projects in South Vietnam and Thailand that can't be done anywhere else

Radios that performed well on maneuvers in the forests of South Carolina and the deserts of California do strange things in Southeast Asia. Dense foliage blocks horizontal radio propagation like a wall while it funnels vertical propagation upward, giving it an increase of 6 decibels above normal.

Engineers from Stanford Research Institute, who are studying the behavior of both high-frequency and very high frequency radio propagation in Southeast Asia, under contract with the United States Military Research and Development Center in Thailand, have made a number of discoveries applicable to Thailand and South Vietnam; radio propagation behaves the same in both.

They have found, for example, that whip or dipole antennas that produce circular horizontal antenna patterns in clear areas, produce multilobed, starfish patterns in heavy vegetation. The nulls between the lobes are areas of complete radio silence. Two troopers no more than two or three miles apart are unable to communicate with each other if one of them is in a null.

Stanford measures antenna patterns by using its Xeledop, a package of eight transmitters for transmitting elementary dipole with optional polarity [Electronics, Oct. 18, 1965, p. 26]. The Xeledop is towed by an aircraft over a number of antennas set up in heavy vegetation. Radar keeps track of the aircraft's position, and the antenna pattern of each ground-based unit is measured.

A Thai officer has made an interesting discovery concerning dipole antennas. Normally dipoles are set up to face each other. The officer found that when he aligned the dipoles north and south, regardless of where the two units were, he got better propagation. When he added dipoles that faced east and west to the north and south pair, propagation improved more.

Stanford engineers have learned that dipoles don't have to be as high as they once believed. Dipoles

1/10 of a wavelength give a signal almost as good as one that conforms to the prescribed ¼ wavelength.

They also tried letting the dipoles sag to see what effect this had. They found that signal strength was not affected much (2 db) until the dipole got down to 45°. But even a sagging dipole, they agree, is better than a whip antenna.

Stanford also is trying to document noise that interferes with radio propagation. One noisemaker is lightning. The Institute wants to know the signal strengths and frequencies affected most. ARN-3 noise recorders monitor noise 24 hours a day on four frequencies. Lightning flash counters also record the number of lightning flashes each day and the time of day most of them occur.

Jansky and Bailey Research and Engineering division of the Atlantic Research Corp. has almost finished a year-long study of factors affecting radio propagation in heavy jungle [Electronics, May 31, 1965, p. 121] and will soon begin another similar project. In the new project, the engineers will make measurements in a jungle twice as dense as the one they are working in now.

The team already has measured the propagation in vegetation with the transmitting antenna 80 feet above the ground and at lower elevations down to 20 feet. They were surprised to find how slight the drop in decibels is when the antenna is lowered.

The engineers also found in the present study that most of the attenuation in deep jungle occurs near the transmitter. The signals that do get through the first wall of vegetation continue for a longer distance that had been expected.

The use of sky waves from h-f radio looks promising for communicating in heavily vegetated areas. Balloons carrying relay transceivers, while theoretically excellent for vhf communications, give away the user's position and they can be shot down.

The Thai government has drawn up specifications for a new man-pack radio that G. Simon Co., a local company, is building. When the radio is finished, Thai officials will run laboratory acceptance tests on it and, later, Thai troops will test it in the field. The unit could be adopted by U.S. forces.

Surveillance

Ways of detecting ambush are being studied in Thailand, but most of this work is classified.

Engineers are making acoustic and seismic background studies to measure the natural background noise and differentiate between it and the noise made by people. They are experimenting with a high quality microphone made by Electrovoice, Inc.

Using seismic instruments, the engineers are measuring the effects of weights dropped from various heights. The information is recorded on magnetic tape and analyzed in the U.S. The objective is to produce a profile of the soil characteristics to using listening and seismic devices to determine the size and number of tanks, troops or other vehicles moving at a distance in darkness. The test also records footsteps.

Infrared has been very successful in locating tunnels close to the surface of the earth, buried camp fires, and other indicators of man's presence. But when the source of the heat is too far underground it doesn't register. Buried metalic objects, however, do register on some devices.

An instrument to detect buried metals could reveal a hidden weapons cache, a deep tunnel where weapons are kept, or even a lone sniper hiding with his rifle in the brush.

The center is experimenting with a rubidium vapor magnetometer built by Varian Associates. "We measure the natural variations in the earth's magnetic field to see if we can find any foreign objects," a colonel working on the project reports.

This kind of device was recently used in Europe to find skiers buried under an avalanche of snow.

Equipment testing

Besides research and development work in Southeast Asia directed toward studying the environment and how best to wage a war in it, the Air Force Systems Command is active in testing equipment. Since Jan. 1, the command in Saigon has received 70 requests from operational units to test equipment for them. These include:

- A sensor to shut down navigation aids before power fluctuation—a common problem among generators—blows them out.
- Eem/elint—a device that automatically gathers data on the enemy's electronic countermeasures and other electronic intelligence. Without an operator, it will automatically record on tape all enemy transmissions from electronic countermeasure devices, radar, and communications equipment; it will also analyze signal characteristics.
- A weather station that one man can carry. It must be disposable and simple enough for an unskilled operator to handle. In unconventional warfare, one man might go into enemy territory and prepare for a larger invasion. He would need to get specific ground weather data and transmit it back to the invading forces.
- Intrusion device. The Air Force is looking at a multipurpose concealed intrusion device that consists of a magnetic detector that is buried under a path. The device once detected hand grenades in a basket of leaves being carried by a harmless-looking peasant woman.
- Small power device for operating a radio which would use body heat to generate its power.

The results of the research and development work in Southeast Asia don't stay only in Thailand and South Vietnam. They feed back to research centers throughout the United States. The work being done with this new information will not only help fight the war in Southeast Asia [illegible]