Chapter 4
FH Networks

4-1. FH Variables

a. SINCGARS hops or changes frequencies about 100 times per second. The radio uses digital processing to control the hopping sequence and the pattern so that the RT arrives at the same frequency at the same time. This ensures the information sent is received and can be decoded. If the sequence were truly random, the receiver could not predict what frequency to hop to next, so the actual sequence is developed in a pseudorandom fashion. The RT uses identical sequencers so the receiver can predict what frequency the transmitter will hop to next. SINCGARS uses the following four variables to synchronize the hopping sequence:

- Hopset.
- TSK.
- Net identifier.
- Julian day/zulu time.

Unless the receiver has all four identical variables, the sequence appears random to a radio outside the network. FH degrades enemy detection capabilities because the output is basically a random pattern. Additionally, several different networks operating in the same area prevent identifying a particular frequency or hopping pattern with any one network.

(1) The hopset is the list of frequencies the frequency manager authorizes for use by a particular unit. The hopset can be specified by a list of discrete frequencies or ranges and groups of frequencies. When a hopset is entered into the radio, the display shows Fxxx. The letters xxx represent a three-digit number that specifies the hopset in use.

(2) The TSK is the digital code that controls the hopping sequence circuits. When FH, the receiver must predict what frequency the transmitter will move to next. The hopset specifies which frequencies the receiver can expect to see. The TSK tells the RT the order the frequencies will appear. SINCGARS uses a pseudorandom code sequence so both radios hop in the same order. The radio's digital circuits generate the hopping sequence, and if both start in the same place and time, they repeat identical codes.

(3) Both radios must start at the same place in the code so the identical code sequence is developed. The net identifier is the variable that determines where in the code to start. The net identifier is loaded into the radio as part of the initial fill of variables. Each network has a unique identifier, therefore, the starting place in the sequence is different for all networks.

(4) Using the same TSK, the netted radios hop in the same sequence over a given list of frequencies. The same net identifier starts them at the same place in the sequence. The only variable left is WHEN to start the hopping sequence. SINCGARS uses Julian day/zulu time as the time variable. The time is entered as day, hours, and minutes. Seconds start when the minute variable is entered. The time set on the radios is arbitrary as long as both radio clocks are within ±4 seconds of each other. The late net entry (LNE) mode allows the clock time to be off up to ±59 seconds and still maintains synchronization. Time can also be entered during ECCM remote fill (ERF) as described below. In any net, only the NCS places the RT mode switch in the frequency hopping/master (FH/M) position. This ensures that the NCS updates the net time synchronization.

b. The variables are unclassified for accounting purposes but are still sensitive in nature. The hopset and TSK variables are stored in the EN or fill device and are loaded into the radios electronically. ECCM fill devices can also be filled by a tape reader and paper tape. The SINCGARS radio is never filled directly from a tape reader. The operator must enter the time, along with any single-channel frequencies, on the keyboard. Although the variables are unclassified, they are kept in the EN with portions of an SOI that is classified. This properly controls distribution of the variables.

c. ERF is another method of loading radio variables. The only stipulation is that the TSK variable must already have been loaded manually. Security regulations state that the radio link must be in the secure mode before ERF transmission. ERF loading can be done in either the single-channel or FH mode. The single-channel q ode is called cold start. Cold start is performed when the radio-channel selector is in the manual frequency position, and the function switch is in the FH mode. Operators perform radio checks on the manual frequency in the nonsecure mode, move to the secure mode, and then perform ERF functions. Under no circumstances will the TSK be transmitted over the radio system. The TSK must be physically loaded by fill device into the radio.

d. SINCGARS uses two single-channel frequencies during FH operations: manual and cue. The manual frequency is used for initial network activation (as described above). It brings outside subscribers into the network when the need arises. The cue frequency allows a subscriber outside the hopping network to notify the network that he desires to communicate with someone in the network. When the single-channel radio calls on the cue frequency, all radios in the hopping network receive audible and visual indications. Essentially, the outside subscriber calls the network, but the NCS or a designated station answers the call. The cue call must initially be made nonsecure for the SINCGARS radio to recognize the signal coming in.

4-2. Unit Standing Operating Procedure (SOP) Considerations

a. The network planners and managers for previous generation single-channel networks considered many options during planning and operating a network. SINCGARS requires the same considerations and adds many more peculiar to FH networks. Some of the FH peculiarities are similar to single-channel planning steps but are more complex (for example, frequency selection versus hopset allocation). This chapter distinguishes between items that apply to both versions of SINCGARS (ICOM and non-ICOM) and items that are unique to each version pertaining to hopsets and TSK variables. The appendix contains a suggested SOP for SINCGARS.

b. The primary consideration for network structure is the capabilities of available equipment. If all radios are capable of SINCGARS compatible FH mode, the network operates in FH. However, if just one of the required radios is limited to single-channel operation, the entire network must operate single-channel. To the extent possible, networks capable of the FH mode should remain in the FH mode to counter Threat electronic countermeasures (ECM) abilities. This problem usually occurs only during combined operations when units must communicate with allied nations. The alternative is to ensure, through prior planning, that a SINCGARS FH radio is cross-attached to the unit concerned.

c. Frequency compatibility and channel spacing of the equipment in the network must be considered in overall planning. AN/VRC-12 series radios and most allied nation VHF-FM radios operate over the frequency range from 30 MHz to 76 MHz. Planners must ensure single-channel operating frequencies are within that range if the network, even if remotely possible, requires communications with the older radios. Older radios operate on 50 kHz spaced channels, while SINCGARS operates on 25 kHz spaced channels. Therefore, the frequencies specified for single-channel networks must be assigned based on the equipment in the network and whether 25 or 50 kHz spacing can be used. The same is true for the cue frequency; it must be on a 50 kHz spaced frequency so any radio can access the network. The BECS automatically assigns the cue frequency on a 50 kHz spacing basis.

d. The unit SOP should address network activation (cold start) and remote fill procedures. For cold start, radio operators load the hopset, COMSEC, and TSK variables before net activation. ERF loading of a fill should be used only if the new subscriber does not have a fill device containing the network's operational hopset. The NCS requests the new subscriber to authenticate using current authentication tables in accordance with procedures specified in FM 24-35 before transmitting the ERF. At a minimum, the radio must have the TSK installed before ERF transfer.

e. The corps/division NCS determines the time reference the network will use. For simplicity, SOPS should specify that the NCS use Greenwich Mean Time (GMT) or ZULU time as the general reference for network operations. It should also specify using the last two digits of the Julian date as the mission day. This eases the ability of operating in two networks at the same time.

f. SOPs should specify using minimum power to provide communications. The adjustable power output capability allows users to tailor the radio for the best possible communications in any circumstance. If the network requires extended range, the SOP should specify using better types of antennas over increasing power. Directional or ground-plane antennas (for example, the OE-303 or OE-254; the RC-292 cannot be used with SINCGARS radios) allow communications over longer distances without increasing the power output. Combining lower power and ECCM methods lessens the probability of Threat detection and interception. Terrain masking and other ECCM techniques should be used to the maximum extent possible. (See FM 24-33.)

g. Using a radio retransmission system is another way of increasing radio transmission range. Retransmission for SINCGARS is simple to set up but prior planning must be done to ensure availability of frequencies or hopsets. SOPs should address the equipment constraints listed in Chapter 5, distribution of the variables to the retransmission station, and the subscribers who require access to the retransmission station. All retransmission operations require two net identifiers for each side of the retransmission station.

h. The unit SOP should specify usual hopset changeover times for network operations. This serves as a guide for normal operating conditions. The hopset may be changed more often if the mission dictates. Units may receive only a few different hopsets. The SOI generated by BECS automatically assign frequencies to maximize use of the available hopsets and frequencies.

i. Since SINCGARS can hold six preset hopsets and eight single-channel frequencies, unit SOP should specify locations reserved for certain functions. Cue and manual frequencies must be loaded in their designated positions for operating the radio properly. The six presets for single-channel frequencies and hopsets should have designated functions so the NCS can simplify network control and operation. Table 4-1 shows a suggested method to allocate the fill positions. In some cases, the single-channel assignments list two options. The first choice is for the radio, if active in a single-channel nonhopping network. The second selection is for a radio that operates full time in hopping mode using the hopsets specified. Position 1 for the FH mode is left to fill with the hopset that will be used most often in the unit. In the FH mode, position 5 is filled with the NRI hopset, secondary command channel, or it may be used for coordination outside normal networks when required (as in joint or rear battle operations). Position 6 is designated for the medical support or medical evacuation (MEDEVAC) frequency. All of the assignments assume a single RT is available for use in a particular installation. A single radio limits hopset loading of preset positions to the six most important nets depending on the situation. SINCGARS can store the six most used hopsets or frequencies. Previously, the operator had to dial in each frequency as it was required. The radio sets containing two RTs are more flexible in assignment of frequencies and hopsets. Generally, for two radio configurations, the radio

with highest possible output contains the frequencies or hopsets for the primary command network, fire support network, and NRI network (if required).

j. Distribution schemes for the TSK variable for the two ground versions are identical. TSKs will be changed every 30 days with a maximum key period of 90 days in emergency situations. In both versions, TSKs are area specific. If missions require users to operate outside the normal areas or to operate with adjacent corps units, the appropriate TSK must be transferred to units involved.

Table 4-1. Fill position allocation.

	SINGLE CHANNEL
POSITION 1	PRIMARY NETWORK FREQUENCY/NRI CUE FREQUENCY
POSITION 2	INTELLIGENCE NETWORK
POSITION 3	COMMAND RETRANSMISSION/NRI AREA FREQUENCY
POSITION 4	ADMINISTRATIVE/LOGISTICS
POSITION 5	NRI/ADJACENT COMMAND OR REAR BATTLE FREQUENCY
POSITION 6	MEDICAL ASSISTANCE FREQUENCY
	FREQUENCY HOPSETS
POSITION 1	PRIMARY COMMAND NETWORK HOPSET
POSITION 2	INTELLIGENCE NETWORK HOPSET
POSITION 3	COMMAND RETRANSMISSION HOPSET
POSITION 4	ADMINISTRATIVE/LOGISTICS HOPSET
POSITION 5	NRI/SECONDARY/ADJACENT COMMAND OR REAR BATTLE HOPSET
POSITION 6	DIRECT SUPPORT (DS) FIRE SUPPORT HOPSET

k. The non-ICOM radio can hold two TSK variables in memory. One is stored in the main operating memory for use as the current TSK. The other is held in a secondary memory until called up for installation into the radio as the operating TSK. Internal circuits erase the current TSK when the secondary is installed. This means that once the secondary TSK is loaded into the main memory, the operator cannot go back to use the first unless he has a fill device with the-first TSK and reloads it into the radio. The TSK for the non-ICOM radio will be common to the corps. This allows members of higher echelon networks to access the lower echelon networks with an ERF of the remaining hopping variables.

1. The unit SOP should address emergency destruction plans for all cryptographic devices. The VINSON and the new ICOM radio are controlled cryptographic items (CCI) and must be destroyed if the unit is overrun. SOP should specify what actions to take and what command level is authorized to implement the plan.

m. The final item for SOP consideration is equipment setup for data networks and designation of the network as a dedicated data network or time-shared voice network. Units which use data devices and networks on a regular basis should dedicate separate net identifiers for the voice and data traffic. SOPs should address hopset allocations and equipment data rate settings for the particular data terminals and the radios.

n. The unit SOP for planning single-channel radio communications should address the following:

- Designation of preset channel functions.
- Operating procedures for single-channel and FH modes.
- Retransmission procedures.
- Hopset use.
- TSK assignments and use.
- Data network configurations.
- Common network time designation.
- Emergency destruction plans.

The planning requirements for SINCGARS are different from those of previous generation radios. Using these criteria and following the operating procedures specified in FM" 24-19, units can expect highly responsive communications support from SINCGARS. The brigade/battalion signal officer (BSO) and brigade/battalion signal NCO (BSNCO) are responsible for ensuring their unit can communicate to fight the battle. Aggressive action is needed to properly train operators and planners in using the new radios.