

RADIO USERS GUIDE AND SYSTEM ORIENTATION

ARAPAHO-ROOSEVELT NATIONAL FORESTS AND PAWNEE NATIONAL GRASSLANDS

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Prepared by: Mark S. Nelson

RADIO SYSTEM WEBSITE: http://gacc.nifc.gov/rmcc/dispatch_centers/r2ftc/FTCRadio.htm

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INTRODUCTION:

This guide is intended to provide basic radio use and system orientation to employees of the Arapaho-Roosevelt National Forests, Pawnee National Grasslands, and cooperating agencies that are authorized to use our system. This guide should be used in conjunction with annual "hands-on" training at district orientations, safety meetings, tailgate safety sessions, and the appropriate handheld and mobile radio manuals (*When all else fails, Read the directions*). It is the responsibility of each employee to understand the radio system and how to use it effectively and efficiently (YOUR HEALTH AND SAFETY MAY DEPEND ON IT). Any employee that does not feel that they have an understanding of the radio system, radios, or their use, should seek individual or group training from their telecom team representative.

The following are references concerning U.S. Forest Service radio system operations and frequency management. Forest Service Manual chapter 6641. The Forest Service Handbook 6609.14 chapter 20, Section 21, Chapter 30, Section 31 and Chapter 40-Radio. National Telecommunications Information Agency (NTIA) Manual Sections 7.3.1, 7.3.4. The Federal Communications Commission (FCC) Part 90 Sections 90.405 and 90.407. The National Fire Mobilization Guide, Sections: 22, 22.13, 23.4 and 65.0, and the Rocky Mountain Area Fire Mobilization Guide sections: 13.0, 22.7, and 24.12.1. The Health and Safety Code Handbook FSH 6709.11

PREVENTATIVE MAINTENANCE PROGRAM:

Radio maintenance is provided by CIO. In the event of a problem with either your handheld or mobile radio notify the home unit radio coordinator (Clayton Terrell or Steve Trujilio) and they can ensure the appropriate steps are taken to restore the radios to service. There are two Preventative Maintenance (PM) Contracts that cover the forests radio system. One is for the "backbone" mountain top repeaters and base radios. The other contract covers each units mobile and handheld radios. The primary function of these contracts are to have each radio inspected on an annual basis before field season to insure that the radios meet factory specifications for operation, are in good physical condition, and to identify any potential problems before they become a potential operational/safety concern. The forest allocates about \$32,000 each year on preventative maintenance of the radio system to provide you with good operating equipment and to provide for your safety. Please do your part by treating the equipment with respect and learn how to use the equipment in a professional manner. *If you take good care of the radio, it will take good care of you when you need it the most!*

FREQUENCY USE, RESTRICTIONS, AUTHORIZATIONS

Current technology of user programmable radios provide capabilities that need to be managed and understood by users to maintain communications in a safe, effective and efficient manner. Frequency management and program standardization are vital tools to insure these goals are met. Each unit has an approved frequency program. These programs are designed to meet unit objectives of: ease of use, required frequencies to accomplish our agency mission, and interagency communications for emergency situations.

There are two federal agencies that manage the radio frequency spectrum. The Federal Communications Commission (FCC) which regulates private, state and local government users, and the National Telecommunications and Information Agency (NTIA) that regulates the federal government users. Only the FCC or NTIA can authorize the use of any given frequency. The local Sheriff or Division of Wildlife officer cannot "give" you a frequency for the purpose of transmitting. Radio Frequency Authorizations must be obtained before transmitting on a cooperators frequency. This requires approval from that cooperating agency, a copy of their FCC license, and an application and approval from the NTIA to use the frequency. Our cooperators must complete a similar process to use the frequencies assigned to the forest (obtain Permission and acquire an FCC license). The telecom team reviews unit frequency lists annually and will seek authorizations for any frequency that has the cooperating agencies approval and a justifiable need. U.S. Radio Frequency Allocation/Spectrum Cgart at: www.ntia.doc.gov/osmhome/allochrt.pdf

THREE RULES OF FREQUENCY MANAGEMENT:

- 1) **Do not transmit on any frequency unless authorized to do so.**
- 2) **Do not use your "home" frequency when in another area.**
- 3) **Never randomly select a frequency to use.**

Only the forests telecom team personnell are approved to program radios. " Emergency Programming Authorizations" are granted to individuals that may have a need to program radios outside of normal operations. Examples are Fire crew leaders sent to another area where proper communications management and oversight may not be available or provided, an individual or crew that works on multiple forests or over a wide geographic area. A Frequency Management and Radio Programming course is held every other year to facilitate these situations. Contact the radio program manager for additional information.

SYSTEM COMPONENTS:

The Land-Mobile Radio System consists of VHF (Very High Frequency) FM (Frequency Modulated) radios (Bases, Repeaters, Mobiles, handhelds), digital net, microwave, and phone links. These components provide for field communications vital to the management of National Forest Lands. The system is designed to provide two-way radio communications over 80% of the forest with a 95% reliability of service.

The Land-Mobile Radio System consists of several components. They include 9 repeater sites, 14 base radio sites, 116 Mobile radios, 232 Handheld radios, 2 Digital net links, 8 phone circuits and a microwave link. **BASE RADIOS:** Fixed location radio system at District office (controlled remotely in some cases), and several Ranger Stations on the forests. Ranger Stations often use a mobile radio with an AC power supply and base antenna. Each Base radio is assigned a call sign. Use the location name when a callsign is not assigned.

BASE STATION LOCATION	CALLSIGN
SO/CLRD/AD-Site (Buckhorn Mtn.)	KAC-249
Redfeather Ranger Station	KAC-246
Stub Creek Ranger Station	KAC-247
Pawnee District Office	KAC-248
Boulder District Office	KCJ-802
Clear Creek District office	KAH-844
Sulphur District office	KAH-836

REPEATER: Radio located on high terrain or mountain top to increase range and coverage of mobile and handheld units. Repeaters receive on one frequency and then re-broadcast (repeat) the signal on a different frequency.

MOBILE: Radio securely mounted in a vehicle (All ARF vehicles, except carryovers, should have a mobile radio installed). These radios work using the vehicles electrical system and have exterior antennas that work much more effectively than a handheld radio.

HANDHELD/PORTABLE: Radio easily carried by field personnel while on foot or using other modes of transportation. When used in a vehicle or aircraft may be connected to an external antenna to improve effectiveness.

PHONE LINES: Used to connect base radios from locations other than an office to improve coverage. The Boulder District office consoles are connected by phone line to the base radio at the Jeffco Airtanker Base at Jefferson County Airport. The AD-Site, Canyon Lakes Ranger Districts and Supervisor's Office consoles are all linked by phone lines to allow access to the base radio located on Buckhorn Mountain.

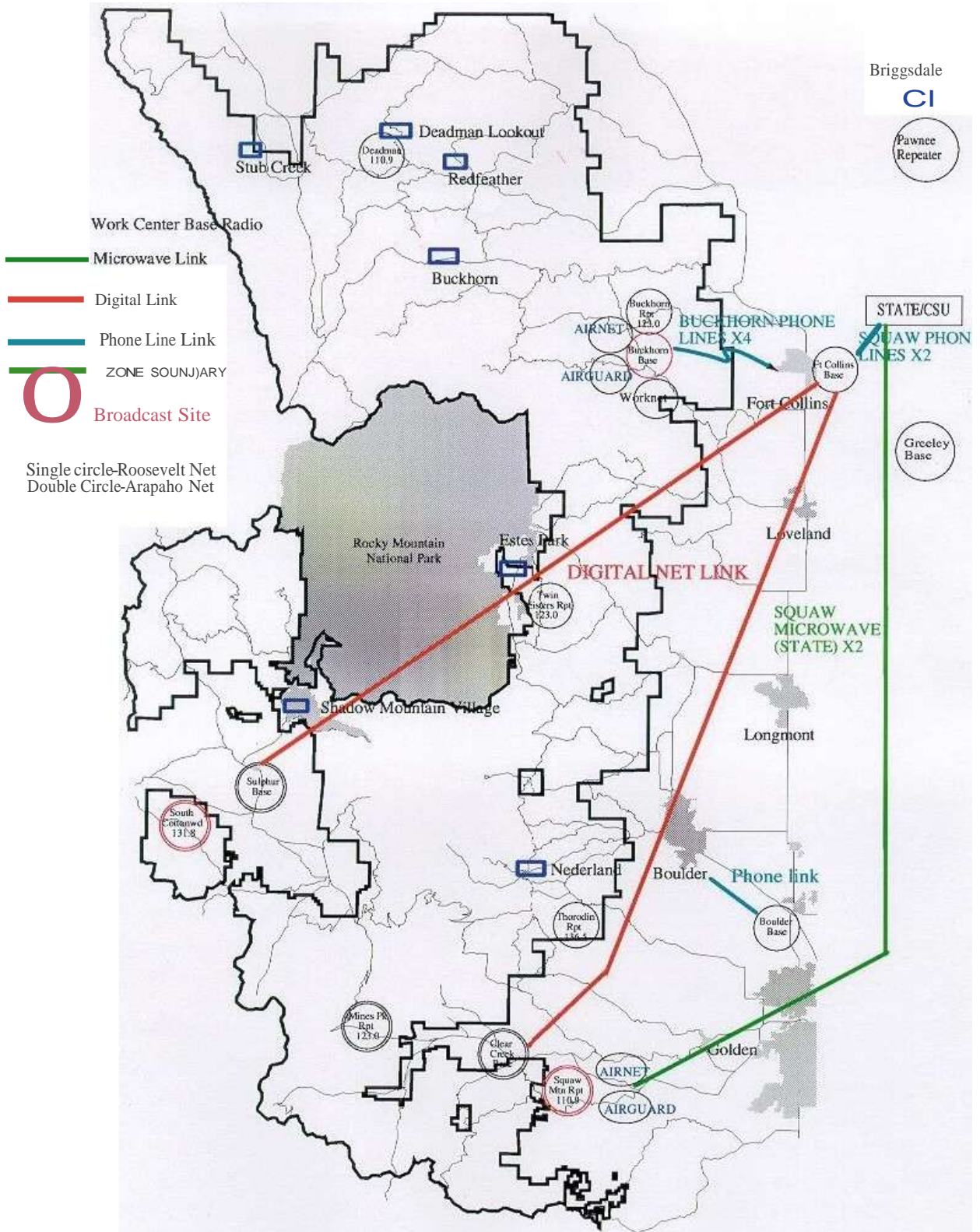
DIGITAL NET LINKS: The Digital Net is the same technology that links the Forests data and voice circuits. There are two digital net circuits that are used to connect the Fort Collins Interagency Dispatch Center to the base radios for the Clear Creek and Sulphur Ranger Districts. This allows for wide area coverage for the center as any of the repeaters can be selected from the remote base radios.

The phone lines and digital nets should be thought of as long microphone cables that link the user to a remote base radio. The console in the office is not a radio, merely a control unit.

There are two main systems on the forest. Arapaho Net serves the Clear Creek and Sulphur Ranger Districts. Roosevelt Net serves the Pawnee National Grassland, Canyon Lakes and Boulder Districts. We use other agency frequencies when necessary during fire, law enforcement, and public safety emergencies. All radio use within the system may be heard or potentially interfere with other personnel using the system. With nearly 400 radios on the forest, the system will be busy at times. Cooperation and consideration by users will help the system meet our needs. Keep in mind that some locations like the Dispatch Center can hear all of the traffic forest wide at all times. You may only hear your local conversation on the Blue Ridge Repeater but there may also be traffic on the Thorodin and Deadman repeaters simultaneously.

Always use a direct frequency whenever possible. A repeater should only be used when direct communications is not possible.

Arapaho & Roosevelt National Forests



DAILY BROADCASTS:

During the field season (around May 15 through September 15th) daily broadcasts will be done to update field crews on local weather and regional and national fire conditions. These broadcasts will be done using the Buckhorn, Squaw and South Cottonwood radio sites. Following is a general outline of the daily broadcasts:

- 08:00 Dispatch Center will broadcast that it is “In Service”. The center may do status checking of suppression resources if weather and fuel conditions warrant.
- 10:30 Synopsis of the National Fire Situation Report, Fire weather forecasts for all applicable fire weather zones (See NWS Fire Weather Operating Plan), and Regional resource availability on planning level 3+ days will be broadcast.
- 16:30 National Fire Danger Ratings and Forecasts.
- 18:00 Dispatch Center will broadcast that it is “Out of Service”.

BASIC VHF RADIO THEORY:

Two concepts important to radio use are “line of sight” and “range”. Our radios operate using FM (Frequency Modulation) in the VHF (Very High Frequency) band. This type of radio transmission has good range and clarity but is, for the most part, line of sight. That is, the transmitter and receiver must not be blocked from one another by mountains, buildings, or other dense or metallic objects. The radio waves will penetrate vegetation and small wooden structures. It is necessary to virtually “see” the other party with which you want to communicate. Our mountainous terrain is our biggest radio communications problem.

Range is influenced by the antenna system, battery condition, and power. The best antenna is a permanently mounted mobile antenna because it is the best radiator and receptor of radio waves, and uses the vehicle chassis as a ground plane for the antenna. ***The typical handheld antenna is a very poor antenna system and explains the difference between the quality of communications between a mobile and handheld radio.***

The key point is that the antenna system is much more critical than the power output. Never use a radio without an antenna attached. Antenna location is also important. If you have the radio on your belt or in a chest pack, your body will absorb much of the signal. While harmless, this will limit the radio’s effectiveness. Try holding the radio up and away from your body. All handheld radios should have a remote speaker/microphone to allow this operation.

Line of sight representations:



Clear line of sight



Clear Line of Sight



Line of sight path is broken



Repeater to provide line of sight

The following charts show the importance of the antenna position, and its clearance, in radio communications. Each -3 db change is equal to 1/2 of the effective radiated power and reception capability. A positive 3 db gain would double the power. -17 db is the difference between 5 watts and 1/10 watt.

IN A VEHICLE:

Radio on drivers hip, antenna clear	-25 db
Radio on drivers hip, antenna pinned behind	-35 db
Radio on seat, speaker up, antenna forward	-36 db
Radio held vertical in vehicle	-17 db
Radio held vertical outside of vehicle	-6 db
Radio in vehicle / magnetic antenna on roof	-2 db

OUTSIDE:

Hip mount 1/4 wave telescopic antenna retracted	-39 db
Hip mount stubby antenna	-17 db
Handheld, stubby antenna angled (Chest Pack)	-10 db
Handheld, stubby antenna verticle	-6 db
Handheld 1//4 wave telescopic antenna at angle	-7 db
Handheld, 1/4 wave telescopic antenna verticle	-2 db
Handheld, 1/4 wave telescopic antenna, remote speaker mic, radio held above head	-0 db

Our system is designed to provide radio coverage over a large area with low power, portable radios. Many factors such as terrain, location, time of day, power, battery strength, antenna system, weather conditions, and vegetation cover can affect coverage. Sometimes you will not be able to communicate. If this happens, you will either need to relocate and try again, or use another field unit to relay your message for you. Often you do not need to move far, simply walking a little way up the hill, driving around a corner, or re-orienting your antenna is all that is needed to establish communications. Always use a "Human Repeater" if you need to establish a contact point. This is particularly true in fire situations. Understanding the radio system and being familiar with your radio are critical to making contact.

The power output of our radios varies from 1 to 60 watts. Most of our portables are 2-watts and the mobiles are 50 watts. Base stations and repeaters typically run at 50 watts. The only control you have over transmitter power is to be sure that you have a good battery to use on handheld radios. Mobiles are most effective if used when the engine is running.

The following chart shows the relationship between power and location. The left side column shows the radio power output. You can see that distance is increased somewhat as you increase power. The row across the top shows the height difference between radios. You can see a considerable increase in communications range when the elevation or "line-of-sight" is increased. There is a dramatic increase in communication range from a mountain top versus using higher power. Note that an increase from 1 watt to 100 watts of output power only increases the communications distance from 5 to 15 miles (a 10 mile increase). If you take the 1 watt output radio to a mountain top you extend your range from 5 to 55 miles (a 50 mile increase). Line of sight, elevation change, and location are much more important elements in VHF radio communications than power output. Always use a battery operated handheld radio in the lowest power mode to save batteries except in those rare occasions when in "fringe" areas.

ANTENNA HEIGHT DIFFERENCE (FEET)	0	20	100	200	MOUNTAIN TOP
POWER OUTPUT (WATTS)		CALCULATED	RANGE	(MILES)	
1	5	9	17	24	55
2	6	10	20	25	59
5	8	13	24	29	65
25	10	17	30	39	72
35	11	18	31	40	74
75	14	22	37	42	78
100	15	23	39	43	80

RADIO USE AND OPERATION: *This guide will only outline some basic elements of radio use and operation. Manuals for all of the Bendix/King models are available from telecom team members and these elements will also be covered at annual orientation sessions.*

RADIO USE:

- Turn on the power. This is done by turning the volume knob clockwise.
- Select the proper channel.
- Adjust the squelch and volume by turning the squelch knob clockwise until static is heard. Set the volume to a comfortable level and then turn the squelch knob counterclockwise until the noise stops.
- Formulate your message before you begin transmitting. Compose a concise, easily understood message.
- Listen for 15-30 seconds to make sure someone else is not using the frequency. Wait for both parties to clear their traffic if the frequency is being used.
- Press the PTT (Push To Talk) switch. The transmit indicator will light.
- Hold the PTT one second then call the person or base station you wish to talk to.
- Release the PTT switch.
- Wait for them to respond. If you do not receive an answer in 10-15 seconds, repeat the call.
- After they acknowledge your call, press the PTT switch again.
- Speak your message in a normal voice with the microphone 1-2 inches from your mouth. Speak distinctly and clearly. Do not shout or speak too fast. Long messages should be broken into segments. Stop at a natural point and say "break". Wait a few seconds then continue the message. Individual transmissions should be 15-20 seconds long.
- Release the PTT switch and listen for your answer.
- Continue pushing the PTT while speaking and releasing when listening until your communication is complete.
- Sign-off by transmitting your last name and the word "CLEAR". Base stations may use a callsign or their location to sign off.

EXAMPLE EXCHANGE:

Jensen: "Nelson this is Jensen."
Nelson: "This is Nelson, go ahead."
Jensen: "Can you meet me at the Buckhorn electronics site in 30 minutes?"
Nelson: "Is one hour O.K.?"
Jensen: "That will work. See you in one hour. Jensen Clear."
Nelson: "Nelson Clear."

BASIC ELEMENTS TO COMMUNICATE:

1. Radios must be on and on the same frequency.
2. Antennas must be present and oriented for best coverage.
3. Batteries and power sources must be good.
4. Units must be in "line of site" and practical range.
5. Use a repeater if "line of site" is blocked to the other unit.

RADIO TRAFFIC PRIORITIES:

1. Communications involving injury, death, or imminent danger.
2. Public emergencies and threat to public safety.
3. New fire or smoke reports.
4. Active fire suppression communications.
5. Law enforcement activities not included above.
6. Normal forest business.

Fires and other extended incidents will be assigned tactical frequencies as soon as possible. Major fires will establish their own radio system with the National Radio Cache System. There are times when you may be asked to stay off the air by dispatch or a district base. This is usually due to your radio transmissions interfering with higher priority calls. You may not be in a position to hear all radio traffic so wait until the base clears all parties to resume normal radio traffic.

THINGS TO REMEMBER:

- Make sure you know the channel settings (use a frequency listing)
- Use clear text-plain english. No 10-codes or other lingo.
- Formulate a clear concise message before you transmit.
- Listen before you transmit.
- Identify with last name, location or callsign.
- Sign Off. Clear the frequencies for others to use.
- Remember Priorities for radio traffic.
- Use "Breaks" during long messages.
- Properly manage and maintain rechargeable batteries.
- The three most important things for communications in mountainous terrain are: Location, Location, and Location.

HANDHELD BATTERY INFORMATION:

Handheld radios work using a variety of battery options. It is important for the user to understand these options and the pros and cons of each type of battery. There are basically three types of batteries that can be used on a handheld radio: NiCad Rechargeable Battery, AA alkaline battery case (Clamshell), and disposable alkaline batteries. Each handheld radio should be issued with two batteries.

NiCAD RECHARGABLE BATTERIES: This is the most common and practical type of battery in use on the forest. It is designed for long life (with proper maintenance) and repeated charge/discharge cycles. This battery requires a basic knowledge to insure proper use and function. A key element to using rechargeable batteries is to always fully charge a battery and then completely discharge the unit before recharging. NEVER partially use a rechargeable battery and then drop it in a charger to “top it off”. This will create what is called a “memory” in the battery and shorten its life span dramatically. With proper care a rechargeable battery will last in excess of 10 years, if improper charging is done it may not last through one field season. Rechargeable batteries come in several capacity sizes. This is referred to as the MaH (MilliAmp Hour) rating. Our batteries range from 800 Mah to 1400 Mah. The larger the rating the potential longer cycle between charges. All rechargeable batteries should go through an evaluation and condition check once a year. Telecom team members each have access to a battery conditioner/analyzer and will perform this function before each field season to insure that all of the batteries are in good condition

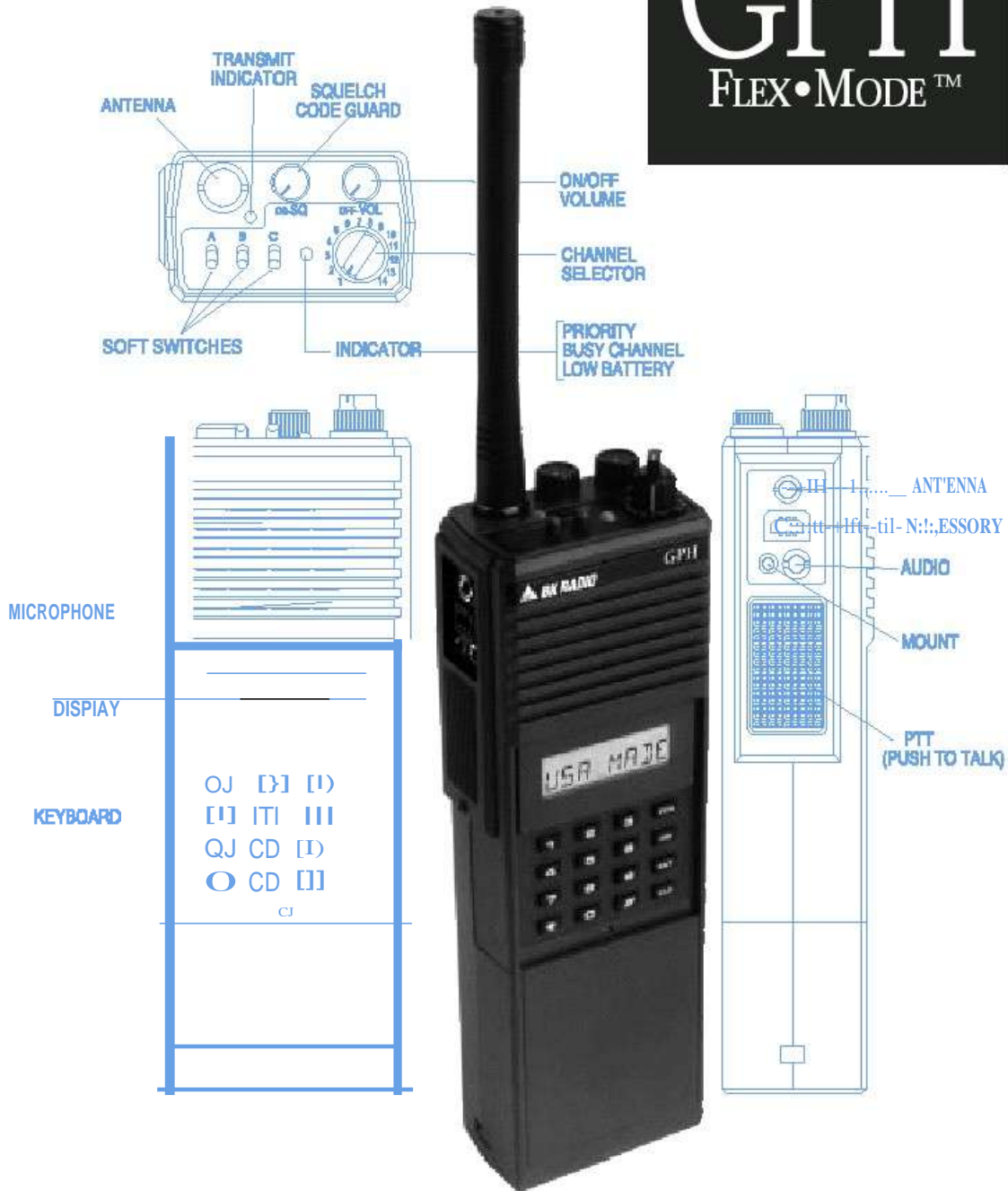
AA ALKALINE BATTERY CASE (Clamshell): The clamshell is used extensively on fires and other situations. Clamshells are essentially a case that looks like a NiCad battery. It will hold either nine or ten AA batteries that can be replaced as needed. There are three very important things to remember about clamshell batteries:

- 1) NEVER use a clamshell with a high power (over 2 watts) radio. The AA batteries do not supply enough amperage to maintain the 5 watt output and will not function in the transmit mode for more than a few minutes. Leave radios with a HI/LOW toggle switch in the LOW position when using a clamshell.
- 2) ALWAYS use the appropriate 9 or 10 AA battery clamshell with the appropriate type of radio. There are actually two types of clamshells, the 9 and 10 battery shells. NEVER remove the retaining band from the 10th slot in a 9 battery shell. *Usually*, the LPH series handheld will use the 10 Cell clamshell and the EPH series radio will use the 9 cell clamshell. Using a 10 cell clamshell on a EPH series radio will eventually damage the radio transmitter circuits.
- 3) NEVER place a clamshell into a charger or conditioner/analyzer. The battery, charger/analyzer, will be destroyed and the risk of a fire is severe due to the high temperatures and battery elements involved. ***Always check the bottom of the battery case for the four silver or gold charging tabs before placing in a charger unit.*** It is recommended that you carry a clamshell (and additional AA batteries) for emergency purposes but not as a primary power source.

DISPOSABLE ALKALINE BATTERY: We are trying to eliminate the use of this type of battery due to its high cost, short usefulness and disposal problems. These batteries look exactly like the NiCad batteries except that they do not have the four silver or gold tabs on the bottom. NEVER place a alkaline battery in a charger or conditioner as a fire or damage to the charger unit may result. The only advantage to these batteries is there relatively long shelf life (several months). If you have an alkaline battery we suggest you keep it in your backpack or vehicle glovebox for emergency use only.

GPH

FLEX•MODE™



THE GPH PORTABLE RADIOS

The Bendix/King Flex•Mode¹¹¹ GPH portable radios offer unmatched reliability and long-lasting performance. Flex•Mode¹¹¹ may be programmed by channel and/or group in 12.5/15 kHz and 25/30 kHz channel spacing. Discover world-class portables for today.

Rely on Flex•Mode¹¹¹ portables to meet the requirements of tomorrow.

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REPEATER OPERATIONS:

Radios called repeaters have been placed on several mountain tops around the forest (see system map). Repeaters extend the range and “line of sight” of any radio. The repeater receives on one frequency and then re-broadcasts (repeats) on another frequency. You must know where these sites are in relation to your location to decide which repeater to use. All repeaters have a unique Channel Guard Tone in their receivers. They will not operate unless the proper Channel Guard Tone is transmitted by your radio and received by the repeater. Channel Guard operation is automatic on most Bank “A” programs but requires the user to select the appropriate Channel Guard Tone from the keypad on Bank “B” programs and some unit Bank “A” programs. *Note that the Buckhorn base radio and repeater are located at the same site. It is not necessary to use the Buckhorn repeater to talk to any of the Fort Collins offices.*

If you are unable to establish contact using a direct “line of Sight” frequency, you will need to try a repeater. Using a repeater is the same as normal operations except in channel selection and possibly Channel Guard selection. To use a repeater:

1. Decide which repeater is closest or provides the best “Line of Sight”.
2. Select the proper channel selection for the repeater or the repeater offset.
3. Select the proper Channel Guard Tone if your radio’s programming requires it.
4. Add the repeater name you are using to the contact call, so the party you are calling knows to use the same repeater. Example: “Jensen this is Nelson on the Twin Sisters Repeater”.
5. You will hear a repeater “Squelch Tail” if your signal is getting into the repeater.
6. If you cannot access the repeater re-check your channel and Channel Guard Tone selections or attempt your call through another potential repeater location.

CHANNEL GUARD TONES:

Channel Guard tones are sub-audio signals that are transmitted to perform special functions like accessing specific repeaters. They allow radios to be programmed using one channel slot for the repeater frequencies and then selecting different tones to access different repeaters. Without the Channel Guard Tones you could potentially access 2, 3 or even 5 repeaters at the same time. This would result in interference from multiple repeaters and an inability to communicate. Telecom team members can give you individual training on this subject and it will be covered in a hands-on approach at radio orientation training sessions. It is important for system users to gain a good understanding of this concept. We have attempted to program Bank “A” in our radios to avoid the use of Channel Guard tones. *Channel Guard Tone operations are complex and the biggest obstacle to employees understanding our radio system design and use.*

GROUP PROGRAM STANDARDS:

Some Mobile and Handheld radios are Multi-Group Radios (Fifteen 16-channel programs). All radios will be programmed with “Group 1” standardized frequency program established for each unit. The unit group programs are designed for simple use and basic agency frequency use. User’s need only select the appropriate channel selection without the need for selecting repeater offsets or Channel Guard Tones. Other groups are specialized for fire and interagency functions. They require the user to understand and implement Channel Guard Tones. Groups 2-12 programming is standardized on a forest and Northern Front Range Interagency basis (See Incident Communications Plan). Groups and Channels are programmed for specific unit needs. Fire groups include frequencies that are authorized for regional and national use. Fire Crews should use the appropriate “Group” in their radios to allow for Northern Front Range interagency communications, national mobilizations. Fire personnel should only have groups 13-15 cloned at fire incidents, this will allow for immediate use of Groups 1-12 upon return to the home unit without having to re-programming. ””