

# Basic Radio Communications Training

The Basic Radio Communications Training that you are taking is part of the Core Competency training plan.

This training is intended to provide SAR teams the basics of radio communications.

Clark County Sheriff Core Comp Rev. # 2018.2  
Basic Radio Communications

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Requirement	Classroom - Performance Criteria
<p><b>Through written evaluation the applicant will demonstrate knowledge of the communications issues involved in Search and Rescue in the State of Washington.</b></p>	<ol style="list-style-type: none"> <li>1. The difference between a frequency and a channel.</li> <li>2. The function of a repeater.</li> <li>3. The function and operation of a manual relay.</li> <li>4. The importance of keeping batteries warm during cold weather.</li> <li>5. A basic knowledge of radio performance and the effects that terrain, distance, and structures have on radio communications.</li> <li>6. A basic knowledge of radio plan "English" and associated procedures.</li> <li>7. A basic knowledge of the county's inter-unit and intra-unit communications procedures, protocols, and frequency's.</li> <li>8. Determine the orientation for best radio wave transmission and reception.</li> </ol>
Requirement	Field - Performance Criteria
<p><b>The applicant will demonstrate the ability to identify the following components on a Search and Rescue radio:</b></p> <p style="font-size: x-small; color: red;">(These Field Performance Criteria - Must be performed in a field setting - Proficiency Must Be Demonstrated)</p>	<ol style="list-style-type: none"> <li>1. Identify the Push-to-Talk switch.</li> <li>2. Identify the Channel/Frequency selector.</li> <li>3. Change the radio's batteries.</li> <li>4. Turn the radio on select radio frequency as identified in the communications briefing (ICS 205).</li> <li>5. Select the channel as requested by search command (frequency change).</li> <li>6. Change radio channel or frequency to a predefined frequency.</li> <li>7. Select state SAR frequency and a command and control frequency (either a county specific or state-wide incident command and control frequency - (i.e. OSCCR -V-TAC - V-CALL)</li> </ol>

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# Basic Radio Communications

- How it works
- Types of Radios
- Other Communications Systems
- Radios for SAR Operations
- Radio Operation
- Communication Problems
- Questions ???

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### How it works

- How does a radio work.
  - Sound vibrations are changed into an electrical signal through the radios microphone.
  - That electrical signal becomes part of signal which is a radio wave.
  - The radio, depending on how its constructed may use amplitude modulation (AM) or Frequency Modulation (FM) radios waves to transmit the signal to another radio that changes the signal back into sound on the opposite end.



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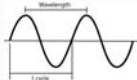
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### How it works

- The first radios were AM type radios. As technology developed and radios evolved they developed into the technology that we use.



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### How it works

- The latest technology can use a digital encrypted signal over a frequency modulated (FM) signal.
- All two way radios regardless of age or sophistication use the same basic principals of operation.
- The radio changes your voice into a signal which is broadcast to another radio via a radio wave and is turned back into a human voice via a speaker.



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## Radios



- What separates radios into different types
  - The frequency band(s) in which they operate
  - If they are an AM (Amplitude Modulation) or FM (Frequency Modulation) device
  - Whether they use an analog or a digital signal.
  - Encryption capability.

AM 

FM 

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## Basic Radio Communications

- Common Types of Radios
  - VHF
  - UHF
  - CB
  - Amateur
  - FRS
  - GMRS
  - MARS
  - MURS
  - Cell Phones



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## Channels vs. Frequencies

- Frequency as it relates to radios is defined as:
  - The rate at which a vibration occurs that constitutes a wave in an electromagnetic field as in radio waves measured per second.
  - For SAR Frequencies the unit of measure for the rate of vibration is Megahertz (MHz).
    - State SAR1 = 155.1600 MHz
- Channels are preset frequency settings that are programed into a radio that can be changed with the turn of a knob or pressing a button on the radio. Frequencies are programed into the radios channels making it easier to change to a preset frequency.

Channel Number	Frequency	Description
Channel 1	155.1600 MHz	Washington SAR 1
Channel 2	155.2524 MHz	Washington SAR 2
Channel 3	155.3025 MHz	Washington SAR 3

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## VHF Radios

- VHF – Very High Frequency
- Most commonly used radio type in ground SAR operations in the Pacific Northwest.
- VHF Frequencies are **136-174** MHz
- Washington VHF SAR Frequencies
  - WASAR1 – 155.1600 MHz
  - WASAR2 – 155.2425 MHz 156.7 pl tone
  - WASAR3 – 155.3025 MHz 156.7 pl tone
  - WASAR4 – 155.1675 MHz 156.7 pl tone
  - WASAR5 – 155.1825 MHz 156.7 pl tone



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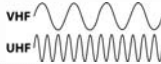
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## UHF Radios



- UHF – Ultra High Frequency
- Limited use in the SAR environment
- Not utilized for public safety in Clark County
- Is the primary radio frequency for Skamania County public safety.
- Used by licensed Ham operators in the area. As well as ARES/RACES groups.
- All cell phones operate in the UHF frequency band 300-3000 MHz.



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## CB Radios

- CB – Citizen Band
- Not used by public safety entities in SAR operations in Clark County.
  - Channel 9 which is designated for "Emergencies" is not monitored by Police, Fire, or 911
- Could be used for in-team communications or during travel in vehicle to vehicle communications.
- Consists of 40 "channels"
  - 26.965 MHz - 27.405 MHz



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## Amateur Radios

- Widely used in the SAR community
- Very wide versatility in VHF and UHF frequency bands.
- Easily programmed to fit the mission or area.
- Now available in dual type "commercial" and "HAM" so radio can be legally used for both purposes.
- Amateur radios and repeaters can be linked to enable longer distance communications between field teams and the Incident Command Post.
- We encourage team members to obtain their Amateur Radio License



13

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## FRS Radios

- FRS – Family Radio Service radios
  - 14 channel radios that operate in the UHF band 462-467 MHz.
  - Of those 14 channels 7 are shared with the GMRS radio frequencies.
  - These radios have the ability to do sub-channels within each of the 14 channels. This is accomplished through the use of PL Tones (covered later). Several sub-channels can be using the same main frequency which can cause severe transmit and receive problems due to the frequency being busy.
  - A total of 42 channels may be designated on your FRS radio. This is accomplished by using the 14 original frequencies with different PL tones.  $14 \times 3 = 42$
  - FRS is limited to 500 milliwatts ( $\frac{1}{2}$  watt) transmit power by the FCC.



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## GMRS Radios

- GMRS – General Mobile Radio Service radios
  - In September 2017 the FCC made significant changes to the GMRS licensing. Starting on 2019 GMRS and FRS radios will no longer be sold as a single unit.
  - Higher power output allowed by FCC (up to 50 watts).
  - GMRS operates in with PL tones which means that it uses a separate send and receive PL Tone frequency for each channel.
  - On most of the hybrid FRS radios the GMRS channels are designated as "High" power channels.
  - GMRS radio started in the 1940's as a "Land Mobile" radio license through the FCC.
  - It has evolved through the years into the current GMRS system.



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## GMRS.....Did you know?

- The FCC still requires that individuals obtain a GMRS license through the FCC. A family can operate on GMRS under a single license.

**The GMRS license does not require a test but does cost \$70.00 for 10 years.**

- A GMRS License can be obtained by visiting the FCC website at:
  - [http://wireless.fcc.gov/services/index.htm?job=licensing&id=general\\_mobile](http://wireless.fcc.gov/services/index.htm?job=licensing&id=general_mobile)

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FRS Designated Frequencies	GMRS/FRS Frequencies				CB Radio Frequencies			
	Radio Service	Frequency Mhz	Channel	Notes	CHANNEL	FREQUENCY	CHANNEL	FREQUENCY
CH - FREQ	FRS/GMRS	462.5625	1	FRS/GMRS channel - 1/2 watt max	1	26.975 MHz	21	27.245 MHz
01 = 462.5625	FRS/GMRS	462.5875	2	FRS/GMRS channel - 1/2 watt max	2	26.975 MHz	22	27.245 MHz
02 = 462.5875	FRS/GMRS	462.6125	3	FRS/GMRS channel - 1/2 watt max	3	26.985 MHz	23	27.255 MHz
03 = 462.6125	FRS/GMRS	462.6375	4	FRS/GMRS channel - 1/2 watt max	4	27.005 MHz	24	27.235 MHz
04 = 462.6375	FRS/GMRS	462.6625	5	FRS/GMRS channel - 1/2 watt max	5	27.015 MHz	25	27.245 MHz
05 = 462.6625	FRS/GMRS	462.6875	6	FRS/GMRS channel - 1/2 watt max	6	27.025 MHz	26	27.265 MHz
06 = 462.6875	FRS/GMRS	462.7125	7	FRS/GMRS channel - 1/2 watt max	7	27.035 MHz	27	27.275 MHz
07 = 462.7125	FRS/GMRS	462.7375	8	FRS/GMRS channel - 1/2 watt max	8	27.045 MHz	28	27.285 MHz
08 = 462.7375	FRS/GMRS	462.7625	9	FRS/GMRS channel - 1/2 watt max	9	27.055 MHz	29	27.295 MHz
09 = 462.7625	FRS/GMRS	462.7875	10	FRS/GMRS channel - 1/2 watt max	10	27.065 MHz	30	27.305 MHz
10 = 462.7875	FRS/GMRS	462.8125	11	FRS/GMRS channel - 1/2 watt max	11	27.085 MHz	31	27.315 MHz
11 = 462.8125	FRS/GMRS	462.8375	12	FRS/GMRS channel - 1/2 watt max	12	27.105 MHz	32	27.335 MHz
12 = 462.8375	FRS/GMRS	462.8625	13	FRS/GMRS channel - 1/2 watt max	13	27.115 MHz	33	27.335 MHz
13 = 462.8625	FRS/GMRS	462.8875	14	FRS/GMRS channel - 1/2 watt max	14	27.125 MHz	34	27.345 MHz
14 = 462.8875	FRS/GMRS	462.9125	15	FRS/GMRS channel - 1/2 watt max	15	27.135 MHz	35	27.355 MHz
	GMRS	462.500	16	frequency of equipment limited - 5 watt max	16	27.145 MHz	36	27.365 MHz
	GMRS	462.525	17	frequency of equipment limited - 5 watt max	17	27.165 MHz	37	27.375 MHz
	GMRS	462.550	18	frequency of equipment limited - 5 watt max	18	27.175 MHz	38	27.385 MHz
	GMRS	462.575	19	frequency of equipment limited - 5 watt max	19	27.185 MHz	39	27.395 MHz
	GMRS	462.600	20	frequency of equipment limited - 5 watt max	20	27.205 MHz	40	27.405 MHz
	GMRS	462.625	21	frequency of equipment limited - 5 watt max				
	GMRS	462.650	22	frequency of equipment limited - 5 watt max				

Clark County Sheriff Core Comp Rev. # v2018.2  
Basic Radio Communications

17

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## M.A.R.S.

- MARS – Military Auxiliary Radio System
  - MARS is a US Department of Defense sponsored program.
  - The program is managed and operated by the Army, Navy, Air Force.
  - It is civilian auxiliary personnel consisting of primarily of licensed amateur radio operators who are interested in assisting the military with communications on a local, national, and international basis as an adjunct to normal communications.
  - There are very specific rules governing the use of the MARS frequencies. They are not for use in local SAR operations.
  - More information is available at [www.usarmymars.org](http://www.usarmymars.org)

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## M.U.R.S.

- MURS – Multi-Use Radio Service also known as “Business Band”
  - MURS is one of five Citizens Band Radio Services (no license required).
  - MURS uses narrowband FM (NBFM) with maximum effective radiated power of 2 watts.
  - There are 5 designated frequencies.
  - No license is required by the (FCC). The current regulations provide your authority to operate a MURS unit in places where the FCC regulates radio communications, as long as you use only an unmodified FCC certificated MURS unit. An FCC certificated unit has an identifying label placed on it by the manufacturer.

MURS Designated Frequencies	
MURS 1 =	151.8200
MURS 2 =	151.8800
MURS 3 =	151.9400
MURS 4 =	154.5700
MURS 5 =	154.6000

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## Cell phones

- Cell phones can be utilized on some searches (mostly urban) for primary or secondary communications and to relay photographs back to the ICP.
  - Must be fully charged prior to deployment
  - Everyone must have reception regardless of their service provider.
  - Cell phone numbers need to be provided to the Communications Officer or ICP prior to deployment
  - Extreme cold and weak signal strength can greatly affect the duration of battery life.

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## Radio Systems in SAR

- Both FRS and GMRS radios are utilized regularly in the SAR environment for inter-team communications.
- Due to the low power output and the sub channel operations FRS and GMRS radio communications can experience problems even in close environments.
- Amateur radios have higher output and greater range of frequencies available.
- Whatever brand of radio system your team chooses to purchase should be compatible with your existing equipment, and able to operate within the guidelines of the standard communications plan in your area.
- The Clark County Sheriff’s Office uses a standing communications plan (ICS205) on all SAR operations. The standard Comm’s plan is available at [www.sarclarkcounty.com](http://www.sarclarkcounty.com)

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## PL Tones / Carrier Tones

- What are PL or Carrier Tones?
  - The most basic explanation is that it is a frequency based switch that the radio can send or receive that allows or inhibits the sending or receiving of a radio signal. The term PL stands for "Private Line" which was first coined by Motorola but has become a industry standard for tone squelch operation of a radio.
- Tone Squelch (uses PL tones):
  - A squelch system (used in wireless equipment) whereby the transmitter emits a tone at an inaudible frequency. The receiver, upon detecting any signal checks to see if that tone is present. If so, it allows the main signal to be heard, otherwise it stays muted.
  - PL tones can be used in both simplex radio to radio operations or with a radio signal repeater.
  - GMRS radio uses PL tones on both the send and receive. By using multiple different PL tones the same frequency can be used by multiple channels. The downside is that the frequency can become overloaded with traffic causing transmit and receive problems.

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## Radios

- Basic Radio Components
  - Power knob or button
  - Volume Control
  - Channel Selector
  - PTT – Push To Talk Control
  - Batteries



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## Icom F70 Radios

- Power/Volume
- Channel Selector
- Zone (up/down)
- Push to talk (PTT)
- Battery
- Function Keys



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## Wouxon KG-UV6D

- Power/Volume
- Channel Selector
- Push to talk (PTT)
- A/B Switch (dual frequencies)
- Battery (back)
- Function Keys

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## Basic Radio Operation

- Be sure the radio is turned on with the volume at a comfortable level.
- Adjust the radio to the proper operational channel.
- Know who you are calling and why.
  - Have an idea of what your going to say before you start.
  - If you need to relay information such as coordinates, have them written down ahead of time.
- Keep in mind the keys to communicating effectively
  - **Brevity** – Be brief in your message
  - **Clarity** – Speak clearly and enunciate your words.
  - **Clear Speak** – Use "Plain English", no jargon, or codes (unless it is protocol for the situation).

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## Radio Phonetics

Ham Radio Phonetic Alphabet (military)						
Alpha	Bravo	Charlie	Delta	Echo	Foxtrot	Golf
Hotel	India	Juliet	Kilo	Lima	Mike	November
Oscar	Papa	Quebec	Romeo	Sierra	Tango	Uniform
Victor	Whiskey	X-Ray	Yankee	Zulu		

Police Radio Phonetic Alphabet						
Adam	Boy	Charles	David	Edward	Frank	George
Henry	Ida	John	King	Lincoln	Mary	Nora
Ocean	Paul	Queen	Robert	Sam	Tom	Union
Victor	William	X-Ray	Young	Zebra		

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## Basic Radio Operation

- Hold the microphone 8-10 inches away from your mouth.
- **Listen** first to be sure that you are not going to cover other radio traffic.
- Press the Push To Talk (PTT) button.
- Wait for ¼ second before you start to speak.
- Say clearly the team/station that you are trying to reach..... then identify yourself, pause and wait for them to answer. If there is no answer wait a few seconds and say-again.



- You say....."SAR Base this is Team One"
- They answer....."This is SAR Base, Go ahead Team One"
- Now you can start to relay your information.
- When receiving information give the "go ahead" when you are ready to receive the information and someone is ready to write it down. Verify any detailed information (such as coordinates) you have received with a read-back of the info to the sender.

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## Operation...

- Remember if giving a list of information such as coordinates, break it into sections of no more than a few digits at a time.
- Don't speed through your information and expect the other end to be able to copy and comprehend the information.
- The person on the other end is likely writing the information down, give them time to do so.



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## Operation...

- Always remember that your transmissions can be heard by everyone.
  - Family and friends of the missing
  - The Media (they scan SAR frequencies)
  - Your team members
  - Other teams
- **Be a professional at all times**
  - If you are not the designated radio operator, **stay off the radio**.



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## Communication Problems

- Send and Receive Problems
- Terrain Limitations
- Manual Relay
- Conditions, Weather
- Equipment Issues



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## Transmit or Receive Failure

- Radio communications are always at the forefront of problems that are experienced in the field.
- Steps to take to troubleshoot communications
  - Verify that the radio is turned on and turned up
    - Is the battery charged and seated properly.
  - Check that your channel or frequency is set correctly.
  - If you haven't heard any traffic for awhile check your frequency setting, it may have inadvertently been changed.
  - Be sure that the antenna is seated and not damaged.
  - If the radio is equipped with accessories such as a corded microphone or earpiece.
    - Remove the accessories if possible and check the function again.



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## Transmit or Receive Failure

- If there is another radio, try communications with that radio to see that it is receiving your transmissions.
- Move to a different location and attempt again.
  - Higher is better.
    - Move to higher ground if possible.
    - Hold the radio up and away from your body and equipment.
    - Move the radio away from other transmission sources such as cell phones or other radios.
  - Change your position to be sure your body isn't blocking the signal.
  - Hold the radio so the antenna is straight up and down
    - This position is typically the best orientation for the strongest signal
  - Send a general broadcast to see if any other team can hear you.
    - Ask the other team to relay the information if you make contact.

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## Transmit or Receive Failure

- Distance and Terrain create challenges and limitations.
  - Radio communications are line-of-sight. (there are no obstacles blocking the radio waves between operators)
  - This can be overcome by the use of a radio repeater or by relaying information through units on the ground.



- When using a team to team or "manual relay" be aware of covering each others transmissions. If you and the ICS are talking to the other team at the same time someone is not going to be heard.
- A radio repeater is an automatic radio signal relay. It forwards the radio signal which allows communications between two points that are otherwise unable to communicate.

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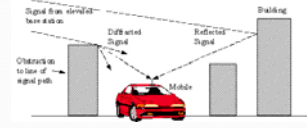
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## Transmit or Receive Failure

- In an urban environment radio communications can be disrupted
  - Buildings can block, weaken, or deflect a radio signal.
  - Noise from other transmission sources even if not heard can affect your transmissions.
  - Bleed over from adjacent frequencies can cause problems with understanding or receiving information by distorting or blocking a signal.



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## Out of Area Operations

- While some frequencies such as Washington SAR 1-3 are reserved for SAR operations statewide other channels/frequencies that you may be used to having available will not be.
- Out of area communications can be a challenge.
- Operations that cross State lines may have problems with radio compatibility.
  - Oregon also uses the same base frequency of 155.1600 MHz for SAR operations (ORSAR Orange), but they use a PL tone in conjunction with that frequency.
  - Know the frequencies of surrounding jurisdictions.
    - They can be programmed into the radio template as part of your pre-planning strategies.

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## Weather

- Heavy rain, snow, and fog can inhibit radio signals.
- Operating a radio in an electrical storm is dangerous.
  - That radio antenna is a great conductor of electricity
    - Get to cover.
    - Ensure that you and your radio antenna aren't the highest point around.



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## Equipment Maintenance

- Batteries
  - Older radios
    - NiCad batteries
    - Charging problems, won't hold a charge
  - Newer radios
    - Nickel Metal Hydride batteries (NiMH) – No “memory” problems
    - Lithium Ion batteries (Li-ion) – No “memory” problems
- Radios should not be stored in the charger.
  - Charge the battery on most radios once a week for 1-2 hours to maintain a full charge.

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## ICS-205 – Radio Comms Plan

1. Incident Name		2. Operational Period (Date / Time)		INCIDENT RADIO COMMUNICATIONS PLAN	
		From: To:		ICS 205-026	
3. BASIC RADIO CHANNEL USE					
SYSTEM / CACHE	CHANNEL	FUNCTION	FREQUENCY	ASSIGNMENT	REMARKS
VHF Radio	VA SAR 1	Primary Communications Channel	155.1600	Field Teams SAR Base	Primary Operations Channel
VHF Radio	WASAR 2	Secondary Backup Channel for open Comms Traffic	155.2425 151.0562 / 150.550	Field Teams SAR Base	Alternate to VA SAR1 if there is other traffic on ground frequency.
VHF Radio	CC/OSAR1	Command Channel	155.3000 simplex	Command Channel	SAR Base command
800 MHz OPS	CTRL 2 Or OPS B7	Communications with CRE/SAR11	800 mhz talk group	Command 911	Primary assigned channel to command to contact CRE/SAR11
VHF Radio SAR1 PEG Sound	Team channel	Inter team communications	162.5625-467.7125	SAR ground teams	Inter team field communications Channel - Team assignment number (i.e., Team 1/Channel 1)
4. Prepared By: (Communications Unit)		J Payne – Clark County Sheriff's Office		Date / Time	
INCIDENT RADIO COMMUNICATIONS PLAN				June 2009	
				ICS 205-026	

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