W2FSR
Forestburg Scout Reservation

Radio Merit Badge Course

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Radio Merit Badge Class – Hour 1

Introduction / Single Side Band Operation

Time	Req.	Outline	Activity / Hand-Out
01:00	1, 7a2, 8	1. Requirements for Amateur Radio Operation a. Radio Transmitter b. Licensed Amateur Radio Operator	**Activity:** SSB Contact
01:10	7a2	2. Starting Weak Signal Call a. Calling CQ b. Answering a Call c. Calling another Station	**Activity:** Have students call and answer CQ. **Hand-Out 1:** Calling and Answering CQ
01:20	1, 3d	3. Use of Call Signs and Identification a. Government Issue of Call Signs i. FCC ii. ITU b. Basic Identification Rules c. Call Sign Prefixes and Suffixes i. US Call Sign Prefixes/Suffixes ii. DX Call Signs	**Activity:** Identify Country of Origin Based on Call Sign **Hand-Out:** Icom Frequency Charts
01:35	1	4. Phonetic Alphabet	**Activity:** Have students give their names phonetically.
01:40	7a2	5. Use of Signal Reports – RST System a. Single Sideband RS b. CW RST	**Activity:** Each student reads the S-Meter on the HF Radio and gives a signal report.
01:50	7a2	6. Logging and QSLing a. Reasons that logging is done. b. Summarize all previous discussion.	**Hand-Out 2:** Logging Contacts **Activity:** A brief HF contact is made. Each student must properly log the contact on his or her own log sheet.

Radio Merit Badge Hand-Out 1

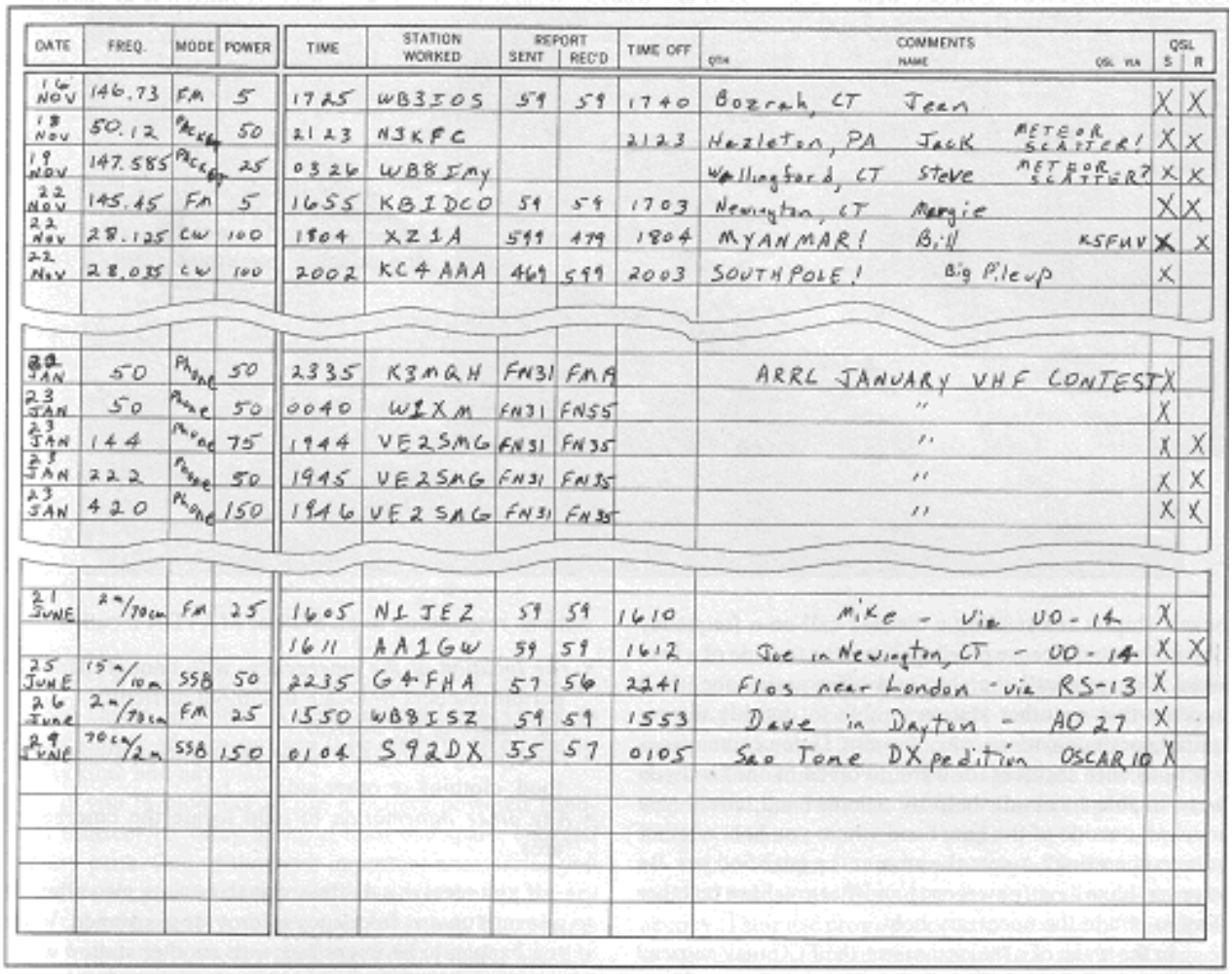
Calling and Answering CQ

CQ CQ HELLO CQ
THIS IS
WHISKEY 2 FOXTROT SIERRA ROMEO
WHISKEY 2 FOXTROT SIERRA ROMEO
WHISKEY 2 FOXTROT SIERRA ROMEO
CALLING CQ AND STANDING BY

WHISKEY 2 FOXTROT SIERRA ROMEO
WHISKEY 2 FOXTROT SIERRA ROMEO
THIS IS
WHISKEY 2 NOVEMBER ALPHA FOXTROT
WHISKEY 2 NOVEMBER ALPHA FOXTROT
OVER.

Radio Merit Badge Hand-Out 2

Logging Contacts



DATE	FREQ.	MODE	POWER	TIME	STATION WORKED	REPORT SENT	REPORT REC'D	TIME OFF	COMMENTS QTH / NAME / QSL VIA	QSL S	QSL R
16 NOV	146.73	FM	5	1725	WB3IOS	59	59	1740	Bozrah, CT Jean	X	X
18 NOV	50.12	PACKET	50	2123	N3KFC			2123	Hazleton, PA Jack METEOR SCATTER!	X	X
19 NOV	147.585	PACKET	25	0326	WB8IMY				Wallingford, CT Steve METEOR SCATTER?	X	X
22 NOV	145.45	FM	5	1655	KB1DCO	59	59	1703	Newington, CT Margie	X	X
22 NOV	28.125	CW	100	1804	XZ1A	599	479	1804	MYANMAR! Bill K5FHV	X	X
22 NOV	28.035	CW	100	2002	KC4AAA	469	599	2003	SOUTH POLE! Big Pileup	X	
22 JAN	50	PHONE	50	2335	K3MQH	FN31	FN49		ARRL JANUARY VHF CONTEST	X	
23 JAN	50	PHONE	50	0040	W1XM	FN31	FN55		"	X	
23 JAN	144	PHONE	75	1944	VE2SMG	FN31	FN35		"	X	X
23 JAN	222	PHONE	50	1945	VE2SMG	FN31	FN35		"	X	X
23 JAN	420	PHONE	150	1946	VE2SMG	FN31	FN35		"	X	X
21 JUNE	2m/70cm	FM	25	1605	N1JEZ	59	59	1610	Mike - via UO-14	X	
				1611	AA1GW	59	59	1612	Joe in Newington, CT - UO-14	X	X
25 JUNE	15m/10m	SSB	50	2235	G4FHA	57	56	2241	Flos near London - via RS-13	X	
26 June	2m/70cm	FM	25	1550	WB8ISZ	59	59	1553	Dave in Dayton - AO27	X	
29 JUNE	70cm/2m	SSB	150	0104	S92DX	55	57	0105	Sao Tome DXpedition OSCAR10	X	

Figure 1: Sample Logbook from *Now You're Talking* 5th Ed.

Practice logging contacts in the table below.

DATE	FREQ	MODE	TIME	STATION WORKED	SIGNAL REPORT		COMMENTS	QSL	
					SENT	REC'D		S	R

Radio Merit Badge Class – Hour 2

FM and CW Operating Techniques; Repeaters

Time	Req.	Outline	Activity / Hand-Out
02:00	7a2, 8	7. FM Communications	**Activity:** 2 Meter Repeater Contact
02:05	7a2	8. Starting an FM Contact a. "Call sign" Listening. b. Answering a call. c. Making a direct call.	**Activity:** A student will give a call sign and say "Listening." Another will answer in a manner appropriate to FM operation.
02:15	7a2	9. Signal reports on FM. a. Full Quieting / Noisy / Unreadable b. Reasons that S-Meters cannot be used on repeaters.	
02:20	7a6	10. Notes on Repeater Operation a. Repeater Identification b. Courtesy Tones	
02:25	7a6	11. Repeater Concept a. Retransmit Incoming Signals using Higher Power and Better Height b. Improves Range of HTs and Mobile Radios	**Hand-Out 3:** Nathaniel's Quick and Easy Guide to Repeaters
02:30	7a2	12. Comparison of FM and SSB Procedures	**Hand-Out 4:** Operational Procedures of Basic Ham Modes
02:35	7a3	13. Notes on CW a. Operating Procedure Similar to SSB b. More Abbreviations and Codes i. K, DE, 73, DX, QRS c. Call CQ at the Speed You Wish to Receive	**Activity:** Allow students to hear a CW QSO. List at least five Q-Signals.

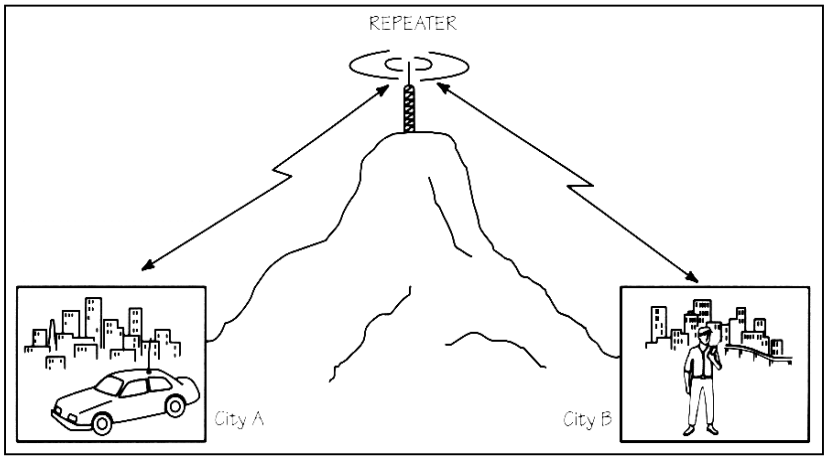
Radio Merit Badge Class – Hour 2 (Continued)

Emergency Operations; Amateur Activities; Licensing

Time	Req.	Outline	Activity / Hand-Out
02:45	7a5	14. Calling for Help (Distress Calls) (Page 4.6) a. On Phone i. Mayday ii. Break b. On CW i. SOS c. Dangers and (Il)legalities of False and Deceptive Signals	**Activity:** Give a scout an emergency situation. Have him demonstrate a proper distress call.
02:50	7a1	15. Activities of Amateur Radio a. General Conversation b. Dxing c. Experimentation d. Public Service e. Emergency Communications	**Activity:** Have scouts discuss different activities that amateur radio operators participate in.
02:55	7a4	16. Licensing a. Technician Class i. Licensing Requirements ii. Priviledges b. Other License Classes c. How to Earn a License	**Hand-Out:** Icom Frequency Charts

Nathaniel's Quick and Easy Guide to Repeaters

VHF (30 MHz to 300 MHz) and UHF (300 MHz – 3000 MHz) radios use **Line-of-Sight propagation**, and therefore the range is limited to slightly beyond the visible horizon line. Mountains and large buildings also reduce range. Repeaters extend the usable range of the radios.



A **repeater** is a radio station that automatically retransmits another station's signal.

Repeaters work by using two separate frequencies. They listen on one frequency, or **input frequency**, and simultaneously retransmit what is heard from the input onto the **output frequency**.

To reduce inference from various sources, radios using repeaters often must send a special code to access the repeater. This code is sent in the form of a **sub-audible tone**, or a tone which cannot be heard by humans. This system is called **CTCSS**, or Continuous Tone Coded Squelch System.

When the repeater is working, a beep will sound after each person finishes talking. This beep is called the **courtesy tone**, and allows for other operators to break in and join the conversation.

Repeaters are radio stations, too!

Therefore, they must identify themselves with a call sign. Amateur (ham) radio repeaters will identify using voice or Morse Code every 10 minutes.

Graphic from BSA Radio Merit Badge Pamphlet, 2001 ed.

Operational Procedures of Basic Ham Modes

	CW	**SSB**	**FM**
Use Phonetics	Not Possible	Almost Always	Only if Necessary
Use Q-Signals	Yes	Sometimes	No
Call Any Station	"CQ CQ CQ de W2FSR W2FSR W2FSR K"	"CQ CQ CQ THIS IS WHISKEY 2 FOXTROT SIERRA ROMEO WHISKEY 2 FOXTROT SIERRA ROMEO WHISKEY 2 FOXTROT SIERRA ROMEO""	"W2FSR Listening."
Call a Station Directly	"W2MSU W2MSU de W2FSR W2FSR AR"	"WHISKEY 2 MIKE SIERRA UNIFORM WHISKEY 2 MIKE SIERRA UNIFORM THIS IS WHISKEY 2 FOXTROT SIERRA ROMEO WHISKEY 2 FOXTROT SIERRA ROMEO"	"W2MSU this is W2FSR"
Answer a Call	"W2FSR W2FSR de W2MSU W2MSU AR"	"WHISKEY 2 FOXTROT SIERRA ROMEO WHISKEY 2 FOXTROT SIERRA ROMEO THIS IS WHISKEY 2 MIKE SIERRA UNIFORM WHISKEY 2 MIKE SIERRA UNIFORM"	"W2FSR this is W2MSU"
Signal Report System	RST (Readability, Strength, Tone)	RS (Readability, Strength)	Plain Language (i.e. "Full Quieting" or "A Little Noisy"
Tell Other Operator to Transmit	Prosign "K" or "KN"	"Over."	"Over" or Courtesy Tone on Repeater
Special Notes	CW uses many abbreviations in addition to Q-Signals.		Use plain language as much as possible.

Radio Merit Badge Class – Hour 3

Definition of Radio / Radio Services and Spectrum

Time	Req.	Outline	Activity / Hand-Out
03:00	1	17. Definition of Radio a. Alternating Current from 20 kHz to 300 GHz	**Demonstration:** Use an oscilloscope to show waveforms.
03:05		18. Relationship of Wavelength and Frequency a. Relationship to Speed of Light b. Relationship to antenna size	**Demonstration:** The instructor and a scout will shake a spring or rope at various frequencies to show the relationship of wavelength and frequency.
03:15	1	19. Uses of Radio a. Transmission Types i. Broadcast ii. Two-Way b. Radio Services i. Hobby ii. Public Service/Government/Millitary iii. Commercial	**Activity:** Scouts will give examples of various radio services and identify them as commercial or non-commercial. Instructor will give an example of a call sign appropriate to each service.
03:25	3a, 3b	20. Radio Spectrum a. VLF/LF/MF (100 kHz – 3 MHz) b. HF (3 MHz – 30 MHz) c. VHF (30 MHz – 300 MHz) d. UHF/Microwave (300 MHz – 3 GHz)	**Activity:** Scouts will draw diagrams of the radio spectrum. The diagrams will include the names, frequency ranges, and general wavelenths of the VLF – Microwave bands.
03:40	3c	21. Spectrum Usage a. Placement of Radio Services b. Value of Spectrum	**Activity:** Scouts will add to their spectrum charts the names and locations of at least 8 radio services. If amateur radio is used as a service, at least 4 bands must be listed.

Radio Merit Badge Class – Hour 4

Propagation: How Radio Waves Travel

Time	Req.	Outline	Activity / Hand-Out
04:00	2	22. Line of Sight Propagation (Page 3.7) a. Common on VHF Bands and Above b. Limited primarily by the Horizon and Topography c. Height, not power, provides greater distance.	**Demonstration:** Demonstrate the Line-of-Site Portion from Demonstration Sheet 1. **Activity:** Students will draw diagrams of Line of Sight Propagation.
04:05	2	23. Ground Wave Propagation (Page 3.3) a. Long Distance for VLF b. Short Distance for Amateur Radio	
04:10	2	24. Sky-Wave/Skip Propagation (Page 3.3) a. Ionosphere i. How Sunspots Affect the Ionosphere ii. Regions of the Ionosphere (Page 3.5) iii. Effects of Day and Night (Page 3.5) iv. Use of WWV and WWVH b. Skip Zones (Page 3.4) c. Backscatter (Page 3.4)	**Demonstration:** Demonstrate the Sky-Wave Portion from Demonstration Sheet 1. **Demonstration:** Scouts will listen to WWV. **Activity:** Students will draw diagrams of Sky-Wave Propagation.
04:25	2	25. Other Propagation Types a. Tropospheric Ducting (Page 3.7) b. Sporadic E	
04:30		26. Propagation and Radio Services	**Activity:** Have scouts look at their radio spectrum charts. Scouts should give whether or not the services that they listed are located in an appropriate area of the spectrum.

Radio Merit Badge Class – Hour 4 (Continued)

Modes and Modulation

Time	Req.	Outline	Activity / Hand-Out
04:35	4	27. Modulation – Changing of a Radio Wave to Add Information a. Continuous Wave (CW) i. Generated by Switching Carrier on and Off ii. About 1 kHz Wide	**Activity:** Students will listen to a CW transmission on the radio. **Hand-Out 5:** Technical Aspects of Basic Ham Modes
04:40	4	28. Amplitude Modulation (AM) a. Generated by Change of Amplitude b. About 5-6 kHz Wide (Amateur AM) c. Not Commonly Used in Amateur Radio	**Activity:** Students will listen to an AM transmission on the radio.
04:45	4	29. Single Side Band (SSB – USB/LSB) a. Created by taking one sideband from an AM Signal b. About 2-3 kHz Wide c. SSB Usage Conventions: USB for above 10 MHz; LSB for below d. More efficient than AM, in both bandwidth and power usage.	**Activity:** Students will listen to an SSB transmission on the radio.
04:50	4	30. Frequency Modulation (FM) a. Generated by Changing Frequency with Respect to Input b. About 10-20 kHz Wide (Amateur Narrow FM) c. Quiet Mode d. Not Efficient in sending information over Long Distances e. Good for Local Communications f. Very Similar to Phase Modulation (PM)	**Activity:** Students will listen to an FM transmission on the radio. Students can also listen to signals using the wrong mode. (I.e. Listening to an AM signal in SSB.)
04:55	4	31. Other Modes a. ATV (Fast Scan ATV has 6-7 MHz Bandwidth) b. Digital Modes i. TNCs ii. Sound Card Interfaces	**Activity:** Demonstrate additional modes if time permits.

Demonstration of Line-of-Sight and Sky Wave Propagation

Materials:

- Laser Pointer
- Ring Stand
- Ring for Ring Stand
- Clear Plastic Bowl
- Water-Proof Hemisphere
- Water
- Powdered Coffee Creamer

Procedure:

1. Attach the flat side of the waterproof hemisphere to the bottom of the clear plastic bowl. This hemisphere represents the earth.
2. Fill the bowl with water. Add just enough creamer to make the water slightly cloudy. At this point, the laser beam should be visible when it goes through the water.
3. Place the bowl in the ring on the ring stand.

Demonstration of the Limitations of the Curve of the Earth on Line of Sight

1. Shine the laser at the sphere. The laser represents a radio wave. Show that the laser travels in a straight line, and cannot go through the sphere or reach the other side.

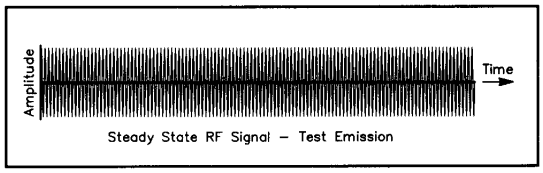
Demonstration of Sky Wave Propagation and Critical Angle

1. Point the laser up toward the top of the water so that the laser beam bounces back down and hits the opposite side of the hemisphere. This represents a radio wave hitting the ionosphere and returning to earth.
2. Change the angle at which the laser hits the top of the water. Demonstrate the concept of take-off angle and critical angle.

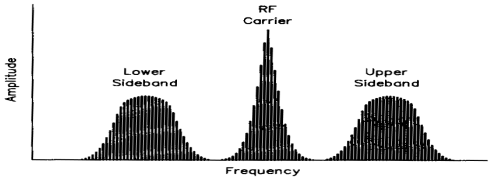
Radio Merit Badge Hand-Out 5

Technical Aspects of Basic Ham Modes

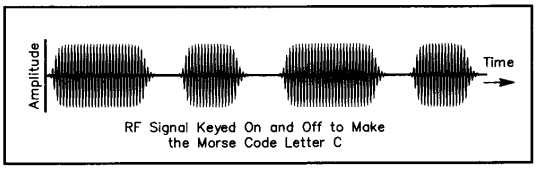
	CW	SSB	FM
Formal Name	Continuous Wave	Single Side Band	Frequency Modulation
Generated By	Turning a Radio Carrier On and Off	Using one side band of an Amplitude Modulated Wave	Changing frequency with respect to Microphone Input
Mode Carries	Morse Code	Voice (Phone)	Voice (Phone)
Bandwidth	About 1 kHz	2 to 3 kHz	10 – 20 kHz
Fidelity	Noisy Mode	Noisy Mode	Quiet Mode
Primary Usage	Long distance communication on HF Bands (Below 30 MHz)	Long distance communication on HF Bands (Below 30 MHz)	Local Communications on VHF, UHF, and above (above 30 MHz)
Capture Effect	No	No	Yes
Special Notes		Exists as USB (Upper Side Band) or LSB (Lower Side Band)	Closely Related to PM (Phase Modulation)



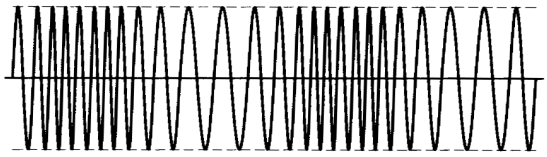
Unmodulated RF Signal



AM Signal (SSB Uses Only One Side)



CW (Morse Code)



FM (Frequency Modulation)

Radio Merit Badge Class – Hour 5

RF Safety and Technical Diagrams

Time	Req.	Outline	Activity / Hand-Out
05:00	5	32. Safety a. Grounding b. Working with Antennas c. Opening up Equipment d. DC vs. AC 33. First Aid a. Personal Safety First b. Saving Someone from Electric Shock	**Activity:** Have a scout act as if he is getting shocked. Have another scout come in and rescue him.
05:10	6a, 6b	34. Block Diagrams	**Activity:** Have scouts draw a block diagram of a computer on the blackboard. Then have scouts draw a block diagram of the HF amateur station that they visited.
05:20	6a, 6c, 6d	35. Circuits a. Short Circuits b. Open Circuits c. Closed Circuits	**Activity:** Draw a schematic diagram of a flashlight. Show how the circuit could be made to be open, closed, and shorted. Compare the diagram to a real flashlight.
05:40	6a, 6d	36. Schematic Diagrams 37. Difference Between Schematic and Block Diagrams a. Block diagrams show larger systems. b. Schematic Diagrams show individual components.	**Activity:** Pass out Geiger counters. Allow students to open them up and identify the components inside. Have students compare the components to the schematic diagram printed on the inside of the Geiger counter. Scouts must identify at least 8 schematic symbols.