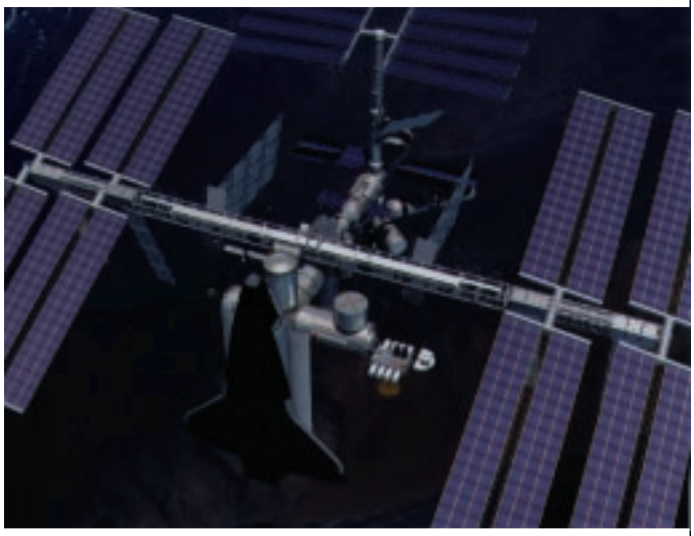
National Aeronautics and
Space Administration

Office of Human Resources
and Education
Education Division

Educational Product	
Teachers and Students	Grades K–4

Amateur Radio in Space

A Teacher's Guide With Activities in Science, Mathematics, and Technology



Amateur Radio in Space—A Teacher's Guide with Activities in Science, Mathematics, and Technology is available in electronic format through NASA Spacelink—one of the Agency's electronic resources specifically developed for use by the educational community.

The system may be accessed at the following address: *http://spacelink.nasa.gov*

Amateur Radio in Space

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Introduction

The Space Amateur Radio EXperiment (SAREX) is designed to facilitate communication between astronauts in orbit with students on the ground. SAREX is sponsored by the American Radio Relay League (ARRL), the Radio Amateur Satellite Corporation (AMSAT), and the National Aeronautics and Space Administration (NASA). SAREX is also supported by the Federal Communications Commission (FCC).

Through SAREX, astronauts make scheduled and unscheduled Amateur Radio contacts from the Shuttle orbiter with schools selected through a proposal process (see Appendix for proposal process information) from around the world. These contacts energize students and families about science, technology, and learning.

The SAREX program will continue on the International Space Station (ISS). Ham radios provide a necessary secondary system component for communication between Shuttle orbiter (and will be for the future ISS) crew members and with Mission Control and workers on the ground.

What Is a Ham or Amateur Radio Operator?

More than 2.8 million people worldwide, including more than 670,000 Americans, are currently licensed Amateur Radio operators or "hams." Oddly enough, there is no universally accepted explanation for where the popular term "ham" originated. Various theories have been put forth, but all are generally discredited. The most likely explanation is that the term derives from the frontier-day custom of referring to unskilled or inept telegraph operators as "ham-fisted." Regardless, it is a term in which Amateur Radio operators take pride.

The term "amateur" refers to one who engages in a pursuit as a pastime rather than as a profession. Amateur Radio is the personal use of short wave radio equipment for direct worldwide communications on a one-to-one basis. Amateur Radio has been a source of communicating and technical skills, especially during an emergency. Hams never accept compensation for services they provide.

The First Space Flights for Ham Radio

On November 28, 1983, Space Shuttle mission STS-9 was launched carrying Mission Specialist Owen Garriott, Amateur Radio call sign W5LFL, and his ham radio into orbit for 10 days on the Space Shuttle Columbia. For seven of those days, hams around the world heard Dr. Garriott's voice calling Earth-bound ham radio stations. Lance Collister, call sign WA1JXN, of Frenchtown, Montana, became the first Amateur Radio operator to work an astronaut-ham orbiting the world, and by the end of the mission, over 300 radio calls were logged by Garriott. The calls ranged from classrooms of children to King Hussein of Jordan. Garriott was even patched in to the Capsule Communicator (CAPCOM) at Mission Control Center to demonstrate the utility of the ham system operating as a backup to some of the orbiter's communication systems. SAREX radios are operated on the conditions that they will not interfere with mission activities and that safety requirements will be met.

The second time a ham radio transmission came from space was on the Challenger STS-51 mission, and a new dimension was added to the already proven techniques used on STS-9. Working with a small group of hams, Mission Specialist Tony England, call sign WØORE, developed the idea of adding a re-

Equipment Configurations

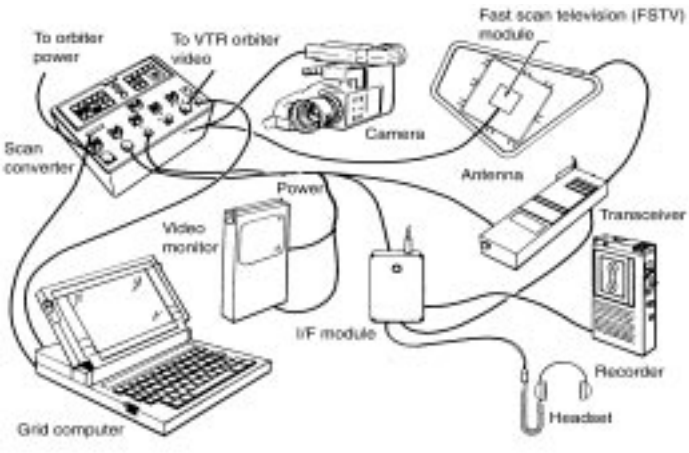

Figure 1. Sample configuration for amateur radio.

peater with a 2-meter radio frequency input and a 10-meter radio frequency output that would also have the capability for slow-scan television (SSTV) uplink and downlink. This mission would determine if television images could be sent and monitored in space. In addition to the 130 voice contacts made—including one from a ham radio mounted in an automobile—there were 10 exchanges involving SSTV signals monitored by the Shuttle ham station. The first SSTV image monitored by Tony England was that of his wife, Kathi. This was the first television to be watched in space.

There are different configurations for Amateur Radio equipment on the Shuttle orbiter. One configuration consists of a hand-held transceiver, interface module, a payload general support computer (PGSC), window antenna, packet radio (digital) module, headset, and terminal node controller (TNC). The TNC interconnects with a radio transceiver so the data to and from the computer is transmitted to and received from the Amateur Radio stations on the ground. This configuration is capable of operating in either the voice or data mode in communications with Amateur stations within the line of sight (LOS) of the Space Shuttle orbiter or Space Station. This configuration can be operated in the attended mode for voice communications and in either the attended or automatic mode for data communications. A similar configuration will be used on the ISS along with other innovative ham radio set-ups.

Another configuration (see Figure 1) consists of a hand-held transceiver, an interface module, a headset, a slow-scan and fast-scan television converter, a television camera and monitor, a PGSC, and an antenna capable of being mounted in one of the orbiter's flight deck windows. This configuration communicates with Amateur Radio stations within LOS of the Shuttle orbiter in one of four modes: voice, Slow-Scan Television (SSTV), data, or Fast-Scan Television (FSTV).

Ground Equipment

An elaborate radio station setup in schools is not required to make a 2-meter radio frequency contact. Ham radio operators will be glad to help with radios and antennas. Contact ARRL (see page 5) for information on how to find a list of hams in your area.

QSL Cards

Specially designed QSL cards (post cards designed by hams to confirm two-way radio contact or reception of signal) are available to anyone who sends a reception report of Amateur Radio operation from the Shuttle orbiter or the future International Space Station. Non-amateurs can listen in on a ham receiver or monitor on scanners to qualify for the special QSL. Send all reception and confirmed contact reports to ARRL.

Licenses

Every Amateur Radio operator must be licensed by the Federal Communications Commission (FCC). In order to obtain a license, a ham must pass examinations in radio theory, rules and, for some licenses, international Morse Code proficiency.

There are Amateur Radio operators from ages 8 to 80, and they qualify for one of five grades of licenses, each at progressively higher levels of proficiency. The five grades are Novice, Technician, General, Advanced, and Amateur Extra. Higher classes of licenses have additional operating privileges. The minimum license required to operate on the frequencies to the Shuttle orbiter and on the future International Space Station is Technician.

Call Sign

The Amateur Radio operator's call letters are issued by the FCC at the time of obtaining a license. The first letter indicates nationality; in the United States the first letters are A, K, N, or W.

There are several means of communicating with Amateur Radio in addition to Morse Code (radiotelegraphy) and voice transmission (radiotelephony). These include radio teletype, computer-data exchange, and fast scan and slow scan amateur television.

References and Resources

AMSAT: The Radio Amateur Satellite Corporation was founded in 1969 to provide satellites that can be used for Amateur Radio communication throughout the world and to disseminate information derived from these communications. For more information, write to:

Radio Amateur Satellite Corporation
PO Box 27
Washington, DC 20044

ARRL: The American Radio Relay League was founded in 1914 as the ham radio operators' organization. ARRL publishes monthly licensing guides, teacher's materials, technical journals and an annual handbook and is the representative body with the Federal Communications Commission. For more information, write to:

American Radio Relay League
225 Main Street
Newington, CT 06111

SAREX on the World Wide Web

ARRL Web Site:
http://www.arrl.org/sarex/

AMSAT Web Site:
http://www.amsat.org

NASA's SAREX Web Site:
http://www.ccsds.org/sarex/

Goddard Space Flight Center Amateur Radio Club:
http://garc.gsfc.nasa.gov/www/

Johnson Space Center Amateur Radio Club:
http://www.phoenix.net/~mbordel/index.html