Astronauts on Your Repeater

Live audio and video from space are available via satellite during shuttle missions, courtesy of NASA TV. But you don't need a satellite receiver to listen in—the astronauts may be as close as your local repeater.

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NASA TV is your best front row seat for what's happening in space. With NASA TV you can look over the shoulders of the flight controllers and astronauts as they perform their tasks. You can watch the same briefings the press watch and find out what's happening first hand. You'll see everything live and uncensored. Instead of one-minute news stories on TV, or newspaper articles written for someone with a sixth-grade education, you'll find out the details. An hour-long news conference may end up on the news as a 15-second sound byte on TV. Often, the rest of the hour is more interesting, but the sound byte was the only "quotable" thing which was said.

"Instead of one-minute news stories on TV, or newspaper articles written for someone with a sixth-grade education, you'll find out the details."

NASA TV also shows archival films from the golden age of the space program—see how NASA presented itself to the world during the moon race and the Cold War and how much the world has changed since then.

On the other hand, even the most die-hard space fans will have to admit that NASA TV can also be the most boring thing on TV. Watching a half-filled control room for eight hours while the astronauts sleep is about as exciting as watching paint peel. Fortunately, many astronauts and flight controllers have excellent senses of humor and bad puns are often heard on the air-to-ground audio, adding some enjoyment to otherwise utilitarian communications.

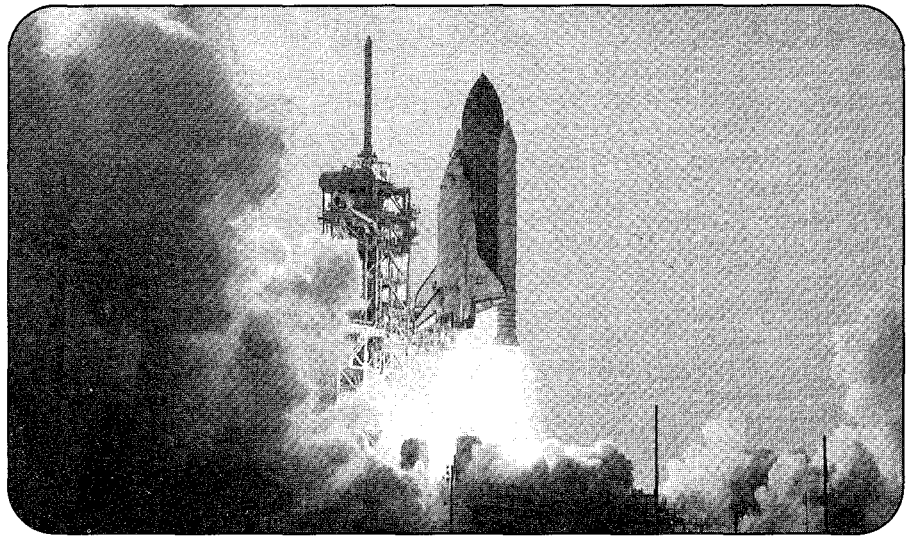

Photo A. Shuttle launches and other NASA activities may be watched live—and without TV anchors' chatter—via NASA TV. Video and audio from shuttle missions may be rebroadcast by hams, and more than 100 repeaters around the U.S. and Canada regularly do so. (NASA photo)

Space Junkie TV

NASA TV was originally called "NASA Select," and was put in place so TV stations around the country could follow the space program without the expense of sending reporters to the Kennedy and Johnson Space Centers. It quickly turned out, though, that the most enthusiastic audience was space fans with access to satellite dishes. NASA-TV, as NASA Select was renamed a couple of years ago, is on the GE-2 satellite, transponder 9C, located at 85 degrees West. It can be viewed by all of North America and Hawaii. (But as we'll discuss later, in many cases, the audio and sometimes even the video, are available on the ham bands as well.)

The NASA TV transponder operates full-time during shuttle missions (Photo A) and other major activities. At other times, programming from NASA's vast library is shown on a four-hour schedule, repeated several times each day. Live activities include press conferences, special activities, presentations from NASA Headquarters, and, most importantly, 24-hour coverage of shuttle missions. This coverage normally gets priority over other programming. See "Resources" for accessing the NASA TV schedule.

Since NASA TV's primary purpose is to inform the media about the agency's activities, much of the programming is presented in a format which requires lit-

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Yes, It's Legal

Here's the full text of the FCC regulation which applies to retransmissions of NASA feeds:

Part 97.113 (5) (e) "No station shall retransmit programs or signals emanating from any type of radio station other than an amateur station, except propagation and weather forecast information intended for use by the general public and originated from United States Government stations and communications, including incidental music, originating on United States Government frequencies between a space shuttle and its associated Earth stations. Prior approval for shuttle retransmissions must be obtained from the National Aeronautics and Space Administration.** Such retransmissions must be for the exclusive use of amateur operators. Propagation, weather forecasts and shuttle retransmissions may not be conducted on a regular basis, but only occasionally, as an incident of normal amateur radio communications."

**Note: NASA has given blanket permission for amateurs to retransmit shuttle communications, so specific request for permission are no longer required.

tle effort on the part of television stations, newspapers, and other mass media to use. So the daily "video file" consists of simple sound-bites and video clips ready to air on the evening news. There's not much substantial information and never a technical term. An outline of each day's "video file" contents may be found on the Internet (see "Resources").

Out to Launch

Launches of NASA payloads on other rockets are also broadcast live; however, non-NASA satellite launches rent commercial transponders. Launches of commercial and military satellites normally are not carried on NASA TV. In the past decade, only one launch of a NASA spacecraft has not been carried live on NASA TV—the launch of the X-Ray Timing Explorer on December 30, 1995, in the middle of the federal government shutdown.

A second transponder, #5, is used for engineering purposes. During countdowns, it's used to transmit launch pad engineering views to engineers at the Johnson Space Center and Marshall Spaceflight Center. It's an unscrambled signal and not purposely encrypted, but it does look kind of strange. Two camera views are multiplexed and, on a normal TV set, it looks kind of like a double exposure.

During missions, the engineering transponder signal is scrambled, officially in order to protect the astronauts' medical privacy, but the scrambling is on continuously, not just when data needs to be protected. During the STS-74 mission, which overlapped the federal government shutdown, the signals were un-scrambled (the personnel responsible for scrambling were not considered "essential" and were not at work). At no point during that mission was the crew's medical privacy compromised. It appears that the key reason for the scrambling is to permit the Johnson Space Center video personnel to choose which air-to-ground signals they wish to send out to the rest of the world and what is to be viewed only within NASA. Regrettably, the existence of the scrambled feed has lead conspiracists and UFO fanatics to believe that NASA is purposely hiding something. And, as with any conspiracy theory, it's impossible to prove that a conspiracy doesn't exist.

Photo B. "Proof" that space aliens exist! Astronaut Tammy Jernigan is "kidnapped" by an alien as seen on NASA TV...on Halloween. Note that the photo is somewhat fuzzy due to jamming attempts by the aliens (not because the author digitized a freeze-frame off his TV).

ET Phone Home!

Speaking of which, UFOs and space aliens have appeared on NASA TV at least once! As the STS-52 crew was packing up the shuttle to return home, a rather strange video came down from space (Photo B). Astronaut Tammy Jernigan was busy working on the shuttle's flight deck when an "alien" appeared on camera and dragged her off screen! The screen quickly went black...and was replaced by a title screen, "Happy Halloween from the STS-52 crew."

After the flight, Tammy admitted, "I'll just say that there's a crewmember who served as our space alien, but he'll remain nameless." She promptly added, "But his initials are MB [Mike Baker]."

On the STS-73 mission, Astronaut Cady Coleman made a casual comment about a UFO entering the Spacelab module, and suddenly the audio stopped. Conspiracists immediately took this as evidence that some high-level NASA official had pulled the plug. The trouble with that theory was that Cady was in the Spacelab module without any external windows, so she couldn't possibly have seen a UFO outside the crew cabin! What she did see was fellow astronaut Mike Lopez-Alegria, and she was kidding him about floating into the cabin. And the reason the audio stopped? There was no need to comment further, and she went back to work. Mystery solved.

Tuning in NASA TV

There are at least five ways to receive NASA TV in the U.S.: C-Band satellite

Table 1. North American Repeaters Regularly Carrying Shuttle Audio and/or Video

Canada

Prov.	City	Freq. (MHz)	Updated	Call	Notes
BC	Vancouver	442.350	12/07/98	VE7RUK	
ON	Waterloo	146.865	11/20/96	VE3RCK	

United States

State	City	Freq. (MHz)	Updated	Call	Notes
AL	Birmingham	443.750	01/01/97	KB4KCH	
AL	Bessemer	53.150	01/01/97	N4AHN	
AL	Bluff Ridge	145.150	01/01/97	N4AHN	
AL	Ensley	145.190	01/01/97	N4IQT	
AL	Huntsville	147.100	04/25/98	KS4LU	Source/Sponsor N4AZY
CA	Los Angeles	448.500	12/04/96	WA6VLD	Mt. Wilson
CA	Los Angeles	1241.250	11/30/95	K6KMN	Mt. Wilson
CA	Los Gatos	440.050	01/15/97	KB5JR	
CA	Mountainview	154.585	11/18/97		NASA Ames
CA	Pasadena	147.150	01/15/97	W6VIO	
CA	Pasadena	224.080	01/15/97	W6VIO	Occasional
CA	Redondo Beach	145.320	12/05/98	W6TRW	PL 114.8 - TRW Radio Club
CA	Sacramento	147.405	03/31/98	N6ICW	
CA	Sacramento	427.250	01/16/97	W6CX/ATV	Video, Ch. 58, Mt. Diablo
CA	San Diego	146.640	02/14/97	WB6WLV	Mount Otay
CA	San Francisco	443.300	01/16/97	KB5JR	Mt. Loma Prieta
CA	Santa Rosa	145.585	04/18/97	W6SRJ	
CA	Sunnyvale	145.585	01/15/97	K6MF	
CA	Ventura	146.655	01/20/97	N6QOL	
CO	Aspen	449.600	03/18/96	NØNHJ	
CO	Boulder	145.460	11/20/96	WA1JHK	
CO	Colorado Springs	145.160	11/20/96	WA1JHK	
CO	Denver	147.225	11/20/96	WA1JHK	
CO	Denver	224.980	11/20/96	WA1JHK	
CO	Glenwood Springs	447.100	03/18/96	KBØSMW	
CO	Grand Jct	449.300	03/18/96	WA4HND	
CO	Vail	449.900	03/18/96	WØKEA	
CT	Bridgeport	441.500	02/15/97	N1LXV	
CT	Bristol	442.850	02/15/97	K1DFS	
CT	Milford	433.100	02/21/97	K1PXE	Simplex
CT	Monroe	463.100	02/18/97		
FL	Clearwater	442.075	09/03/97	K4LK	
FL	Cocoa	421.750	03/28/96	K4ATV	Video & Audio Ch. 57
FL	Dunedin	145.230	08/06/97	K4LK	
FL	Fort Lauderdale	145.210	05/20/96	KA4ZAY	
FL	Fort Lauderdale	145.750	01/21/97	KE4TP	
FL	Fort Lauderdale	442.650	05/20/96	KA4ZAY	
FL	Holiday	427.250	08/06/97	K4LK	Video & Audio Ch. 58
FL	Jacksonville	144.360	04/21/98	W4YJC	Simplex - PL 179.9
FL	Largo	51.840	01/08/97	K4LK	
FL	Macclenny	144.330	04/21/98	W4YJC	Simplex - PL 173.8
FL	Merritt Island	146.940	11/30/96	K4GCC	Next to Kennedy Space Center
FL	Miami	146.850	08/27/98	AA4EE	
FL	Palm Bay	145.170	01/13/97	KF4APQ	Only during launch/landing
FL	Port Richey	443.950	01/08/97	K4LK	
FL	St. Petersburg	147.285	01/08/97	K4LK	
FL	St. Petersburg	444.700	08/06/97	K4LK	
FL	Sarasota	442.550	01/08/97	K4LK	
FL	Tallahassee	146.910	04/22/98	K4TLH	Tallahassee Amateur Radio Society
FL	West Palm Beach	147.360	10/30/98	WB4FPB/R	Palm Beach Repeater Assn.
IL	Champaign-Urbana	146.880	11/30/93	KA9SZX	

IL	Champaign-Urbana	426.250	11/30/93	KA9SZX	video
IL	Lisle	224.360	11/20/96	AF9M	Link from Schaumburg
IL	Moline	146.550	06/19/96	KB9BNR	Grid EN41
IL	Schaumburg	446.575	04/01/97	K9MOT	Motorola ARC
IL	Schaumburg	910.250	02/26/97	K9MOT	AM video only
IN	Warsaw	446.050	01/20/97	N9NJK	
MD	Greenbelt	3.860	05/19/97	WA3NAN	Only when crew awake
MD	Greenbelt	7.185	05/19/97	WA3NAN	Only when crew awake
MD	Greenbelt	14.295	05/19/97	WA3NAN	Only when crew awake
MD	Greenbelt	21.395	05/19/97	WA3NAN	Only when crew awake
MD	Greenbelt	147.450	05/19/97	WA3NAN	Only when crew awake
MN	Minneapolis/St. Paul	145.150	11/26/96	WBØGDB	
MN	Waseca	147.450	02/12/97	KØQX	
MS	Bay St. Louis	146.700	03/26/96	WB4FUR	
ND	Fargo	446.600	11/20/96	KEØVN	Simplex
NJ	Lincroft	439.250	11/19/96	N2SMT	Video & Audio
NJ	Paterson	146.610	12/03/97	W2FCL	
NM	Artesia	146.820	12/29/96	KU5J	Occasional
NM	Artesia	442.000	12/29/96	KU5J	
NV	Las Vegas	449.500	02/12/97	N7TND	
NV	Las Vegas	1241.000	02/12/97	KB7BY	Video & Audio
NY	Albany	920.800	11/30/95	KD3NC	
NY	Long Island	145.430	12/03/97	N2QPD	
NY	Troy	447.225	11/30/95	KD3NC	
OK	Tulsa	146.805	02/11/97		
OH	Akron	147.330	02/12/97	WB8CXO	
OH	Cleveland	145.670	12/01/95		NASA Lewis ARC
PA	Harrisburg	147.375	10/25/96	WA3KXG	
PA	Pittsburgh	145.620	02/15/97	WA3PBD	
PA	Pittsburgh	421.250	02/22/96	WA3PBD	Video & audio
SC	Charleston	147.345	03/24/97	KD4TXX	Early evening to midnight
SC	Lyman	144.340	05/15/97	KF4DET	
TN	Pigeon Forge	146.450	11/07/98	N4YEK	Simplex PL-67hz
TX	College Station	147.540	01/14/97	W5AC	
TX	Dallas	445.000	01/14/97	WB5EPI	
TX	Houston	146.640	11/22/96	W5RRR	
TX	Houston	171.150	05/29/96		NASA/JSC
TX	Temple	145.310	07/16/97	N5ZXJ	
TX	Waco	910.250	03/18/96	W5TAH	Video and audio
UT	Brigham City	145.290	05/17/96	KE7FO	Thiokol ARC
UT	Ogden	449.775	05/17/96	N7TOP	
UT	Orem	448.025	01/13/97	N7HMF	
UT	Payson	147.400	01/13/97	NV7V	
VA	Chesapeake	144.340	10/13/98	KO4FR/WA1TSS	
VA	Chesapeake	427.250	10/13/98	KO4FR/WA1TSS	Video
VA	Chesapeake	431.750	10/13/98	KO4FR/WA1TSS	

Table 1. The amateur radio operators listed above have indicated that they retransmit NASA TV audio on a regular basis. Special thanks to Bill Bard, WD4IXI, for permission to reprint it. Contact Bill at WD4IXI@amsat.org with any changes or corrections. This list is also available online at <http://www.amsat.org/amsat/sarex/shutfreq.html>.

dish, Dish Network, cable, Internet, and amateur retransmissions. NASA news chief Brian Welch stated "All of the material that airs on NASA TV belongs to the taxpayer. So all of the material is in the public domain and we're happy for folks in the country, and even around the world, to receive it however they can. We don't run a television station, it's primarily a source for the news media for information. It's more of a resource to provide information to the news media so they can cover the space program."

The best way to receive NASA TV is on a C-Band satellite dish. For most of the U.S. a five- to eight-foot dish is adequate. The GE-2 satellite has a solid signal over the contiguous U.S. and Hawaii (an EIRP, or effective radiated power, of about 37 dbW over the contiguous U.S., with a 31-dbW spot beam aimed toward Hawaii; see Figure). All other things being equal, the quality of the signal is proportional to the size of your dish. If you're willing to accept a mediocre signal with a bunch of snow, then a dish as small as three or four feet may be acceptable, but it will be a pretty rotten signal.

Plus, with a relatively small satellite dish, you may encounter some "spill over" from adjacent satellites, especially if you live west of the Mississippi. Still, a mediocre signal is better than no signal

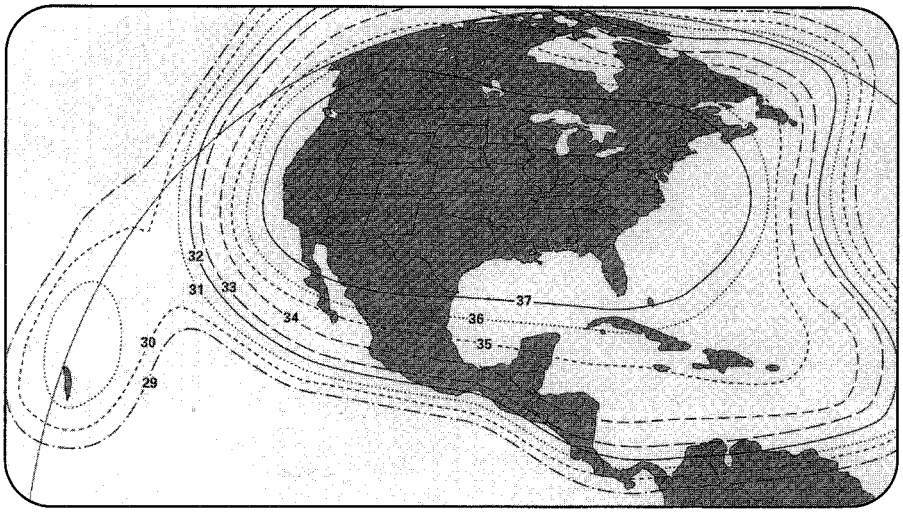

Figure. The "footprint," or coverage area, of the GE-2 satellite, which carries NASA TV signals. Numbers indicate signal strength in dBw (decibel watts) and show a strong 37-dBw signal over the contiguous 48 states, plus a 31-dBw "spot beam" over Hawaii.

at all if you live in a location where a larger dish isn't practical (or permitted).

Many hams have put together a C-Band system out of spare and used parts for less than $100. A more sophisticated and better-quality setup can range anywhere from $500 to $1,500, depending on your technical abilities and scrounging skills.

GE-2's footprint covers North America. On some shuttle flights with strong international participation (for example, one carrying a European crewmember), a commercial broadcaster or the other country's space agency may choose to retransmit NASA TV on an international satellite, providing coverage outside North America.

The only small satellite dish service (Primestar, DSS, Dish Network) which includes NASA TV is the Dish Network (Echostar), which carries NASA TV on channel 213 on Echostar 3, along with other niche programming, international shows, network broadcasts from local stations around the country, and high-speed data transmissions. Echostar 3 is visible from most locations east of the Rocky Mountains. It's an extremely powerful satellite, so only a 12-inch dish is required. If you have an existing single-dish Dish Network setup, the second dish can be added for a nominal charge.

Some cable companies and wireless cable firms carry NASA TV at least on a part-time basis. Cable and DBS (direct broadcast satellite) companies pay broadcasting companies on the basis of the number of subscribers, typically a couple of cents to a couple of dollars per month per subscriber. Since NASA TV is created by the government for public distribution, the cost to the cable company is as low as it can be: zero cents per customer. As a bonus in areas where cable is regulated, NASA TV counts towards the cable company's required "educational content." How often NASA TV is on depends on the company's policies, and whether or not somebody in charge is a space fan.

Ham Retransmissions

Amateur radio operators have retransmitted NASA TV during shuttle missions since 1983. Over 100 amateur radio repeaters regularly retransmit NASA audio, and many amateur television groups retransmit the NASA TV video signal. The list of frequencies on which NASA TV may be heard and/or seen in different parts of the country may be found in Table 1.

John Anderson K4GCC, a ham who lives near the Kennedy Space Center, was the first to retransmit NASA TV, starting with the STS-7 mission in June, 1983. The Goddard Amateur Radio Club, WA3NAN, started its transmissions on the Goddard VHF repeater a couple of months later, on August 31, 1983, seven hours before the launch of STS-8. Goddard's shortwave retransmissions started with the STS-9 mission. (Table 2 lists the frequencies and antennas at the Goddard retransmission site.)

The Johnson Space Center Amateur Radio Club, W5RRR, started its VHF NASA audio retransmissions in October 1983, shortly before the STS-9 mission, which featured the first use of ham radio aboard a spacecraft, by Astronaut Owen Garriott, W5LFL. Several other hams were granted FCC waivers for permission to retransmit NASA audio. In 1990, the ARRL sought permission to retransmit shuttle communications. NASA agreed, and the FCC amended its rules to permit the retransmissions of the air-to-ground audio. See "Yes, It's Legal," for the entire text of section 97.113 (5) (e) of the FCC's rules.

While the FCC rule says you must get permission from NASA before retransmitting shuttle communications, NASA has given blanket permission for any amateur radio operator to retransmit NASA TV. So there's no requirement for any individual to request permission from NASA. It's also important to note that the FCC waiver specifically permits music originating from NASA to be

Table 2. NASA TV Audio Retransmissions by the Goddard Amateur Radio Club

Frequency (MHz)	Mode	Antennas
3.860	LSB	N-S/E-W Dipoles
7.185	LSB	N-S/E-W Dipoles
14.295	USB	3-element Yagi
21.395	USB	5-element Yagi
28.650	USB	4-element Yagi
147.450	FM Simplex	Phased vertical (Washington, DC, local area)

Table 2. Retransmission of shuttle air-to-ground audio from WA3NAN may be heard on the frequencies and modes listed above. A shortwave receiver with a Beat Frequency Oscillator (BFO) is needed to receive either LSB (Lower Sideband) or USB (Upper Sideband) transmissions.

retransmitted via amateur radio, but that the waiver applies *only* to *shuttle* retransmissions. There is *no* waiver in place for other NASA TV activities, such as spacecraft landings on other planets, news conferences, or other non-shuttle activities.

Where can you hear these ham-band retransmissions? Just about anywhere, either on VHF or HF...and sometimes even in space! A couple of years back, Dr. Shannon Lucid was finishing her stay on the Mir space station, along with her Russian crewmates Valeri Korzun and Sasha Kaleri. She said "I saw STS-79 after it had launched and it was like a great big white star. And while I was watching it at one window, Sasha came and said "quick-quick come." He wanted me to listen to it on the ham radio, which was in another module, so I flew in there and listened [to the K4GCC repeater in Florida]."

Finally, you can "watch" NASA TV on the Internet. At minimum, you should have a 28.8k modem and a 100-MHz processor. Two sources for streaming video are <http://shuttle.nasa.gov/real data/index.html> and <http://www.broadcast.com/events/nasa/>.

The Future of NASA TV

Each year when NASA's budget comes up for review in Congress, someone always questions whether NASA TV is worth the cost. It's an extremely expensive operation, with several television studios in remote locations, high production values, and two dedicated satellite transponders. So far, NASA TV has survived the budget ax, but its future is always in question. There have been experiments with highly compressed fiber-optic video distribution, and anything which could save money will certainly be considered. If you want to show your support for NASA TV, the best thing to do is send a letter to your member of Congress, explaining how useful it is to you.

NASA Select has evolved over time into NASA TV, and will certainly continue to evolve as NASA changes to adapt to the new century. When it was started, nobody thought it would have such a wide-reaching audience, or that it would it would affect how the general public could find out about NASA's activities.

Next month (July), we'll take a look at the Shuttle Amateur Radio Experiment (SAREX) and how you can talk to the astronauts via ham radio. ■

Resources

The Goddard Amateur Radio Club WA3NAN may be contacted by several methods. Mail: Goddard ARC/WA3NAN, P.O. Box 86, Greenbelt, MD 20768-0086; Phone (during missions): (301) 286-6673; Internet: telnet to <wa3nan.gsfc.nasa.gov> (128.183.105.17); Modem: (301) 286-4137 (up to 14.4 kbaud supported); Packet Radio: WA3NAN on 145.090 MHz in DC area; World Wide Web: <http://garc.gsfc.nasa.gov/www/garc-home-page.html>.

NASA TV schedules are available on the World Wide Web at <http://www.nasa.gov/ntv/>. The shuttle TV schedule is located at <http://shuttle.nasa.gov/realdata/nasatv/schedule.html>. It is important to note that times in schedules are estimates and events may not always begin as scheduled.

An outline of each day's NASA "video file" telecast may be found on the Internet at <ftp://ftp.hq.nasa.gov/pub/pao/tv-advisory/nasa-tv.txt>.