

Underwater Shooting

camera is a good example, as are broadcasts from helicopters, from television cameras loaded onto dirigibles, or from miniature cameras attached to a stadium ceiling. These techniques, showing the action from unusual camera angles, are highly successful in producing effective visual images.

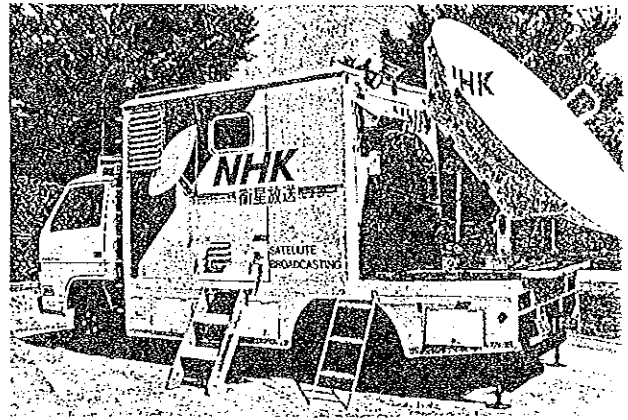
In recent years, as cities have grown taller and regions for coverage have grown broader, it has become increasingly difficult for the broadcast signals — image and sound — to reach the Broadcast Center from outdoor sites. Buildings, hillsides, and mountains block the microwaves carrying the image and sound. In response NHK has set up FPU receiver bases on the roofs of tall buildings or other sites with good visibility, to relay broadcasts to the Broadcast Center. If reception is still a problem, other means, including setting up temporary relay points for multistage transmission or using a helicopter as a relay point, are employed. The use of helicopters, in particular, has contributed greatly to expanding relay regions. The development of compact automatic tracking equipment for helicopters has also made possible better coverage of events that cover distance rapidly — a marathon, for instance. A broadcasting vehicle following the race can now reliably transmit a running view of it using a helicopter as its relay point. If a road or river between the broadcast site and the broadcast vehicle prevents laying a camera cable, moreover, a simple optical FPU can be used instead.

Satellite Broadcasting

Satellite television broadcasts have already begun in Japan. On-vehicle earth stations are used to send programs directly from a non-studio site to the broadcasting satellite. To broadcast from outlying islands, sites of fires or other disasters, and other locations difficult of access, knock-down portable earth stations can be loaded in helicopters and airlifted to the broadcast sites.

At the NHK Broadcasting Center, the radio control room controls audio and video transmissions from the outdoor broadcasting sites, FPU receiver bases, and other sources. At the Broadcasting Center, all on-site programs from the Kanto region are processed; received, allotted to the correct studio within the Broadcasting Center, or directly broadcast.

Outside broadcasting goes beyond covering events within Japan. International television transmission using the Intelsat satellites in orbit over the Indian and Pacific oceans is now a commonplace event. Every day, news broadcasts are transmitted at a set time. Moreover, there is a growing trend, when overseas events of special interest such as US-Japan summit talks or an international sports meet are scheduled, for NHK to dispatch a team to transmit on-the-spot telecasts and news reports back to the audience in Japan.



On-Vehicle Earth Station

Audio Program Production

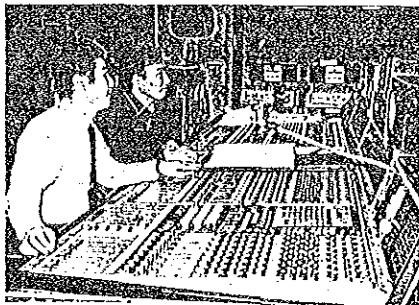
The Broadcasting Center houses 26 sound studios, used for producing the sound for television programs as well as for radio and satellite broadcasts. The studios differ in size and facilities, so that the appropriate one is selected for use according to the scale of the program and its audio requirements. For instance, Studio CR-509 is used for large-scale music programs, Studio CR-506 for medium-sized music programs and audience-participation programs, while CR-506 is used to produce music programs for which particularly high fidelity is needed.

The control room for each studio is equipped with an audio mixer, tape recorders, and record players and has an announcer's room attached. Of the 26 studios, 17 have stereo program production capacity.

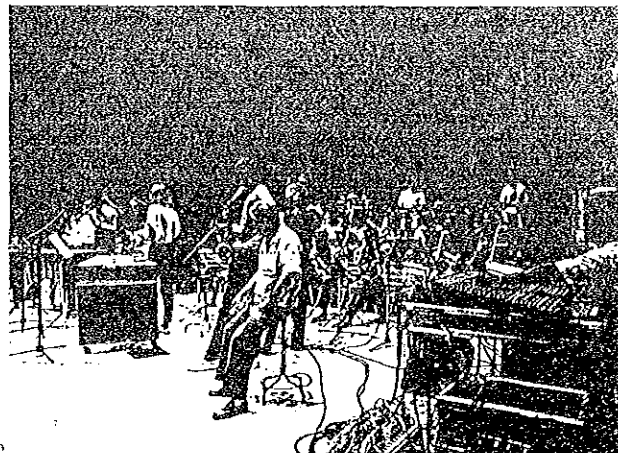
In recent years, satellite broadcasts and high definition television programming have been improving video image quality and necessitating an improvement in audio quality as well. The spread of compact discs and digital audio tape (DAT) recordings, moreover, is raising listeners' expectations with respect to audio broadcasts. In response, NHK is updating its equipment and introducing new equipment to achieve higher fidelity in audio broadcasting. Two special studios and an audio broadcasting van are among NHK's tools for achieving enhanced audio quality.

Sound Studios in NHK Broadcasting Center (as of March 1987)

Studio	Studio Area (m ²)	Reverberation Time(sec.) at 500Hz	Announce Booth Area (m ²)	Mode
CR-131	21	0.19	-	Mono
-132	15	0.16	-	Mono
-313	17	0.17	-	Mono
-314	17	0.17	-	Mono
-350	83	-	-	Mono/Stereo
-401	15	0.15	-	Mono/Stereo
-402	15	0.15	-	Mono/Stereo
-403	15	0.15	-	Mono/Stereo
CD-404	15	0.15	-	Mono/Stereo
CR-405	15	0.15	-	Mono/Stereo
-406	15	0.15	-	Mono
-407	15	0.16	-	Mono/Stereo
-408	15	0.16	-	Mono/Stereo
-501	160	1.0	-	Mono/Stereo
-502	160	0.56-0.73	15	Mono/Stereo
-503	160	1.0	-	Mono/Stereo
-504	160	0.56-0.73	15	Mono/Stereo
-505	368	0.7-0.9	15	Mono/Stereo
-506	337	0.15-0.81	-	Multi studio
-509	540	1.1-1.3	15	Mono/Stereo
-601	177	0.36-0.55	15	Mono/Stereo
-602	90	0.43-0.62	15	Mono/Stereo
CP-603	-	-	10	Mono/Stereo
CR-604	52	0.31	-	Mono
-605	91	0.46	11	Mono
-606	91	0.46	11	Mono



Multi-Recording Studio Control Room



Mixing a Music Program

Special Studio

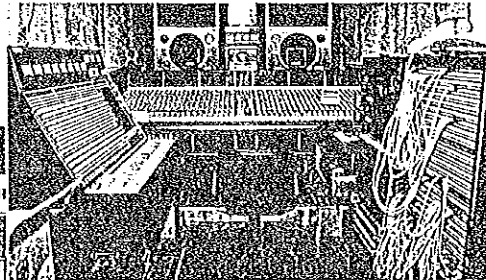
Studio CR-506, the multi-recording studio, is structured and equipped for recording the sound of each instrumental part separately, to achieve clearer, more precise sound in audio programs. Within the studio, there are three booths and three alcoves to permit separating the musicians by instrumental part. The central section of the studio can also be divided, by means of large moveable partitions, into two zones with different acoustical properties. The separate areas of the studio are effectively insulated from each other to permit clearer pick up of both louder and softer groups of instruments. The studio is also equipped with new devices for enhancing acoustic effects, such as variable reverberation or sound chimneys that exclude low frequency unwanted sounds. Its control room is equipped with a multi-channel mixer that can accept up to 56 separate inputs and a 24 channel pulse code modulation (PCM) recorder.

Studio CP-603 is another specialized studio, designed for PCM recording with digital signal processing capability. It is equipped with a PCM production console, four PCM recorders, a digital audio disc (DAD) player, and other sophisticated equipment for high fidelity sound recording.

The Audio Broadcasting Van

It is very inefficient to haul bulky audio equipment to concert halls and similar sites outside the studio and set it up to broadcast an orchestra or rock concert. Moreover, the ad hoc approach makes achieving fully satisfying audio quality highly difficult. The audio broadcasting van, however, facilitates outside production of such large-scale programs efficiently with high audio fidelity.

What makes the audio broadcasting van special is, in addition to its chamber acoustic characteristics and outstanding sound insulating properties, its commodious and convenient interior. The walls and ceiling of the audio broadcasting van are double insulated to provide excellent sound insulating qualities. The level of room noise is extremely low. The mixing room (20 m³) within the van is surrounded with acoustically absorptive material 250 mm thick. To permit program production at large-scale events such as rock concerts and audience-participation programs, the van is equipped with 130 microphone input circuits, a 48-channel main audio controller, and a 24-channel sub controller. In addition, the van has computer-assisted mixing capabilities and two 24-channel PCM recording devices.



Audio Broadcasting Van (left) and Its Interior (right)

Broadcasting Networks

Under the provisions of the Broadcast Law, NHK has set up multiple networks for AM and FM radio and television broadcasting over which it provides reliable radio and television broadcasts.

Radio Networks

NHK carries out AM radio broadcasting in the medium wave (MF) band over two networks, Radio-1 and Radio-2. The stations in these networks include main stations with studios for producing programs and relay stations that simply translate the audio signal from the main stations into the appropriate frequency of radio waves.

The main stations have a large power output (1 kW to 500 kW) and serve widespread areas. The relay stations, with their smaller outputs (100 W to 1 kW), serve more limited areas. Entirely solid state

design is used in radio broadcasting equipment of up to 10 kW in output, but the large output transmitters, 50 kW and above, still use tetrode tubes in their final stage.

Since the first experimental station opened in Tokyo in 1957, listeners have taken pleasure in NHK FM's high fidelity broadcasts. The FM network now covers the whole country with stereo broadcasting, using main stations and relay stations that, in most cases, share facilities with television transmission stations. Joint use by FM and television of antennas and power supplies results in greater cost efficiency.

TV Networks

NHK television broadcasting is handled by two networks, the General Service and the Educational Service; both broadcast in color using the NTSC format. Television penetration in Japan increased rapidly with the 1964 Tokyo Olympics, as the accompanying graph of television broadcasting network growth makes clear. Initially the 12 VHF channels sufficed, but the dramatic increase in the number of stations led to difficulties over allocating channels within those wave lengths. VHF broadcasting has been supplemented by the UHF band since 1963.

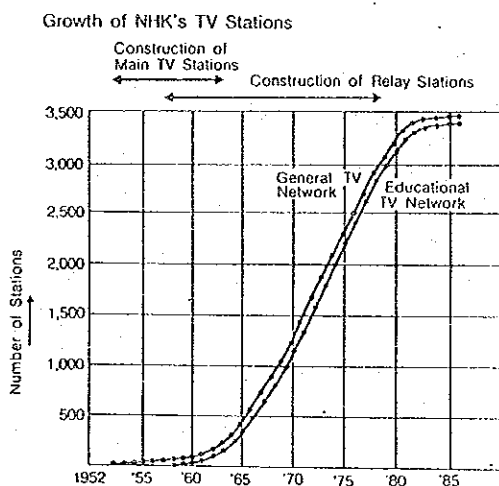
The main stations, which transmit video and audio signals from the studio converted into the appropriate radio frequencies, have a transmitter output of between 1 kW and 50 kW and usually serve wide areas. The relay stations, which receive the radio waves from the main stations, convert their wave lengths, and retransmit them, are generally located on mountain peaks difficult of access. With outputs of 0.1 W to 3 kW, they serve comparatively limited areas. Given the large number of its stations, NHK has worked to standardize the relay transmission equipment for efficient operation and maintenance with highly reliable fully solid state transmitters. A system has been agreed upon, for mini transmitters serving a few hundred households, to broaden the bandwidths of the antennas and amplifiers to permit joint use by NHK

Number of Stations (as of March 1987)

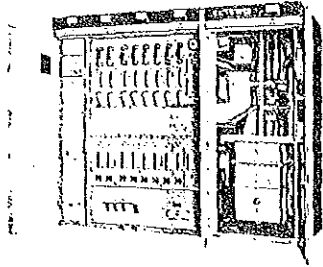
Networks	Number of Stations			
	Frequency Band	Main Stations	Relay Stations	Total
General TV	VHF	43	428	471
	UHF	9	3,015*	3,024
Educational TV	VHF	42	428	470
	UHF	3	2,946**	2,949
Radio-1	MF	54	134	188
Radio-2	MF	51	90	141
VHF-FM Radio	VHF	58	447	505

* Includes 841 mini power stations

** Includes 832 mini power stations



Solid-state UHF TV Transmitter



and commercial broadcasters. At present 90 per cent of the 841 mini transmitters are shared with commercial broadcasters.

Multiplex Broadcasting

Multiplex broadcasting, in which a second sound channel is added, permits bilingual and stereo broadcasts. Multiplex service began in Tokyo and Osaka in 1978 and was expanded to reach the entire country by the end of March, 1987.

Teletext Broadcasting

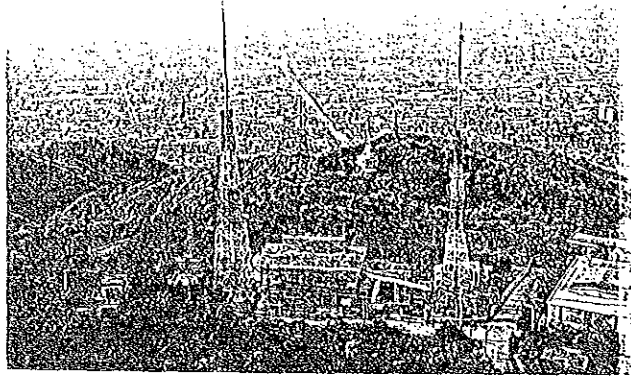
Experimental teletext broadcasts* transmitting text and graphic data using the field blanking periods between video signals began in 1983.

Initially teletext broadcasts used the pattern method but later improvements led to a hybrid of the pattern and code methods. Nationwide service with the hybrid method was achieved by the end of March, 1987.

Operation and Control

In general, the operation of transmitting station for television, AM and FM radio is automatic. Thus, at the main stations, backup systems are provided for the facilities to increase reliability, while an automatic control system has been introduced that efficiently organizes and analyzes a vast volume of data on the operating status of the system and on malfunctions. Mini computers are also in use at some stations to oversee radio wave characteristics and signal quality automatically. Of course, remote supervision and control from studios is also possible.

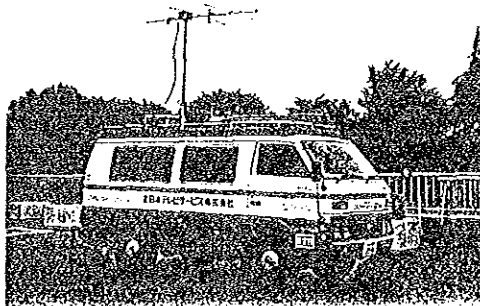
Osaka TV Transmitting Station



Supervision of relay stations is carried out by local inspectors appointed by NHK; they are provided with reception sets and other equipment to monitor relay station operation. Relay stations serving a large number of households, however, use automatic reporting devices that report data on malfunctions more rapidly over telephone circuits. In addition, some relay stations are equipped with supervisory and control devices with the capability of supervising picture quality by means of still pictures.

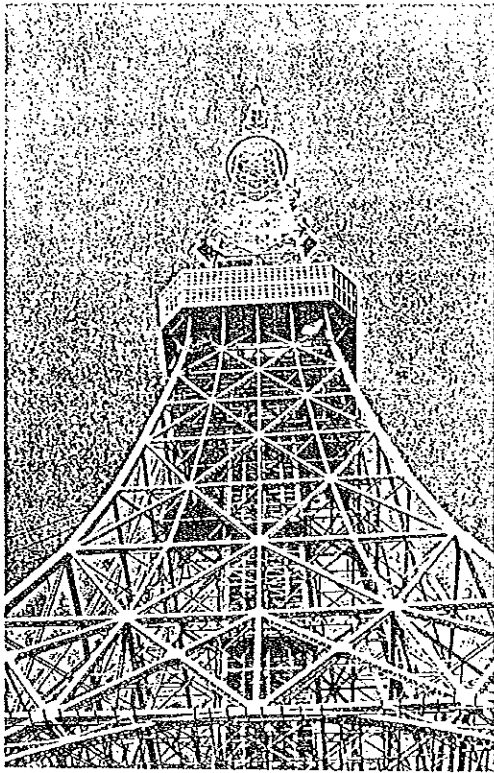
Micro computers and measuring devices are also loaded on special vehicles for field checks, measuring the quality of the picture transmitted in the relay station's service area and the corresponding electrical characteristics. The data collected and stored through the field check system are analyzed to contribute to the efficient maintenance and improvement of NHK's broadcasting facilities.

Field Check Van



Tokyo TV and FM Transmitting Station

NHK's Tokyo television and FM transmitting station is housed in Tokyo Tower, the landmark structure that rises high above Tokyo's Shiba Park. From the very top of this 333 meter tower, superturn antenna transmits two television services; Channel-1 (General Service) and Channel-3 (Educational



The TV & FM Transmitting Station in Tokyo Tower Covers the Tokyo Metropolitan Area

Service), and the VHF-FM service.

The service area for this transmitting station is the national capital zone and its surrounding region. Within this service area are 10 million households, making this TV and FM transmitting station NHK's most important. Maximum reliability was built into the equipment systems from the design stage to ensure highest quality and stability in the signals.

The television broadcasting equipment consists of three 25 kW transmitters, of which two are used in parallel to produce a rated output of 50 kW, while the third transmitter is kept as a stand-by respectively. Thus, if by the slightest chance anything should happen, the system will ensure that broadcasting does not stop; and even in the worst cases, transmissions would still continue, though at a reduced output. Reliability is thus ensured by the distribution of equipment in this kind of redundancy system. In addition, as a precautionary step to deal with natural disasters such as earthquakes or fires, a back-up transmitting station with an output of 10 kW has been reserved at a site 2 km from Tokyo Tower, to make assurance doubly sure.

The equipment at the Tokyo television and FM transmitting station can be kept under remote-control and monitored from the Broadcasting Center, but as well as this, because of the need to have a full up-to-the-minute knowledge of the working condition of the equipment and quality of signal emission, various data is automatically recorded and surveyed by a data logger.

Facilities of Tokyo Television and FM Transmitting Station

Item	Television		VHF-FM radio
	General service	Educational service	
Antenna type	6-stack superturn		8-stack supergain
Frequency	91.25MHz (Visual) 95.75MHz (Aural)	103.25MHz (Visual) 107.75MHz (Aural)	82.5MHz
Effective radiation power	250kW (Visual) 62.5kW (Aural)	280kW (Visual) 70kW (Aural)	44kW
Transmitter output power	50kW	50kW	10kW
Transmitter configuration	Consisting of 3 sets of transmitter blocks (2 concurrently running with one spare)	Consisting of 3 sets of transmitter blocks (2 concurrently running with one spare)	Consisting of a pair of transmitter blocks (Concurrently running)
Transmitter type	Solid-state (MOS-FET) with one 8F 68 tube (visual) in each transmitter block	Solid-state (MOS-FET) with one 8F 68 tube (visual) in each transmitter block	Solid-state with one 8F 76R tube in each transmitter block

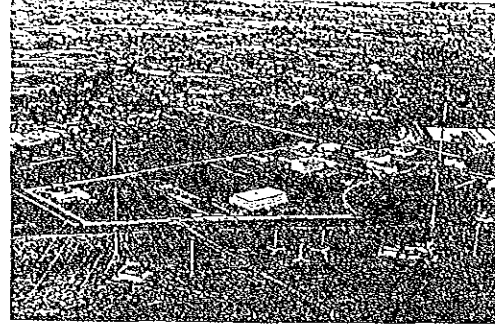
Tokyo Radio Transmitting Station

The Tokyo Radio Transmitting Station is situated in Shobu-cho, some 50 km to the north of the capital. It transmits two medium wave services, the Radio-1 service, with a power output of 300 kW, and the Radio-2 service, whose output power is 500 kW, making this transmitting station one of Japan's largest in scale and most up-to-date.

With the spread of television broadcasting, and the passing of time, the role played by radio has changed, yet to the audience it is still perceived as the medium they feel closest to. And apart from its usefulness in daily life, it is particularly important in times of disaster as an essential source of information.

The service area of the Tokyo Radio Transmitting Station is centered in the Kanto region but also extends to cover the Tokai, Koshinetsu and part of the Tohoku regions — in other words the whole of eastern Honshu from the Japan Sea Coast to the Pacific Coast and from the Tokai region bordering central Honshu up to and overlapping with the northern Honshu region. It thus serves approximately 13 million households, almost one-third of the number of registered receiving households in the nation. In addition, during the night its transmissions reach as far as the Chugoku region, which is west of central Honshu, Shikoku and the southern part of Hokkaido, and it is playing a role in the rectification of mixed signals, which have been increasing in recent years as a result of foreign transmissions. In the system design of the broadcasting facilities, full consideration has been given to supplying

Tokyo Radio Transmitting Station



good quality, stable service with no breaks in transmission, and particularly to maintaining full functions in times of emergency or disaster.

The transmitters for the Radio-1 service are three high-performance, highly reliable 150 kW units. Two of them are operated in parallel, producing an output of 300 kW. As a result, even if one were to break down, there would be absolutely no interruption to the service, and transmission would continue as normal. The most up-to-date equipment is employed throughout the installation, as can be seen in the use of computers for monitoring and for control of the transmitters and power generators. In this way the facilities have been automated and staffing rationalized. In addition, dependability has been increased by the use of antenna structures with excellent resistance to seismic shocks and emergency use power equipment employing gas turbine generators. Furthermore, the entire system has been strengthened by the establishment of a back-up transmission station at Kawaguchi, about 30 km away.

Facilities of Tokyo Radio Transmitting Station

Item	Radio-1	Radio-2
Antenna type and height	Base-insulated mast with top hat 245 meters high	Base-insulated mast with top hat 215 meters high
Frequency	594kHz	693kHz
Effective radiation power	450kW	700kW
Transmitter output power	300kW	500kW
Transmitter configuration	Consisting of 3 sets of transmitter blocks (2 concurrently running with one spare)	Consisting of a pair of transmitter blocks (Concurrently running)
Transmitter type	Solid-state (MOS-FET) with 3 9F45 tubes in each transmitter block	Solid-state (MOS-FET) with 4 9F45 tube in each transmitter block
Transmitter power efficiency	65% or more (with no modulation) for each transmitter block	65% or more (with no modulation) for each transmitter block

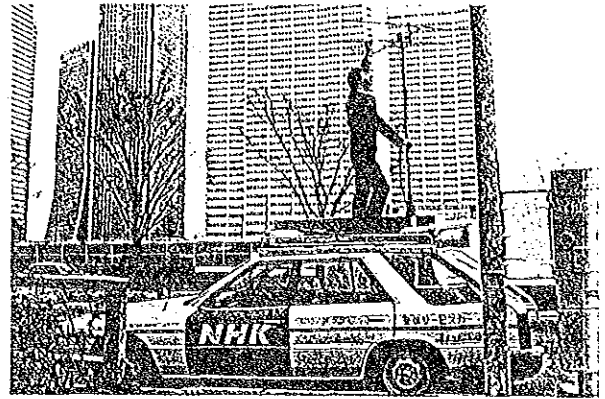
Reception Counselling Service and Improving Reception

To improve reception of its programs, NHK is active in providing technical counselling on reception and in popularizing new broadcasting services. A growing problem in urban areas is reception interference due to high-rise buildings. To prevent such interference, NHK provides technical assistance to the construction industry: estimates of the area that will suffer interference from a particular building and methods of improving reception. In addition, NHK also carries out research on the causes of various reception problems and their solutions and develops improved reception devices.

Reception Counselling

NHK receives about 200,000 listener inquiries a year concerning radio and television reception. In addition to responding by telephone or letter to these inquiries, NHK may, depending on the nature of the problem, call upon the person at home to make an on-site study of the reception problem and suggest means of solving it. The majority of inquiries concern radio noise or ghost images caused by high-rise buildings, but recently requests for information concerning reception of satellite broadcasts, teletext broadcasts, and other new broadcasting services have been on the rise.

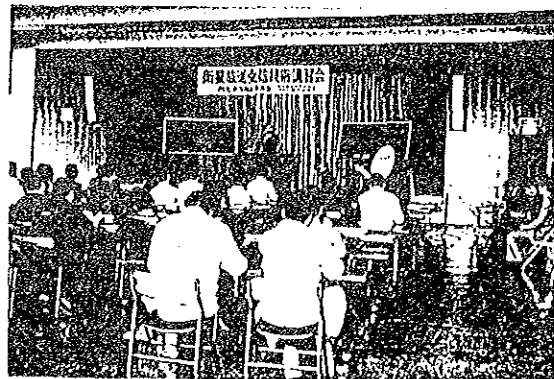
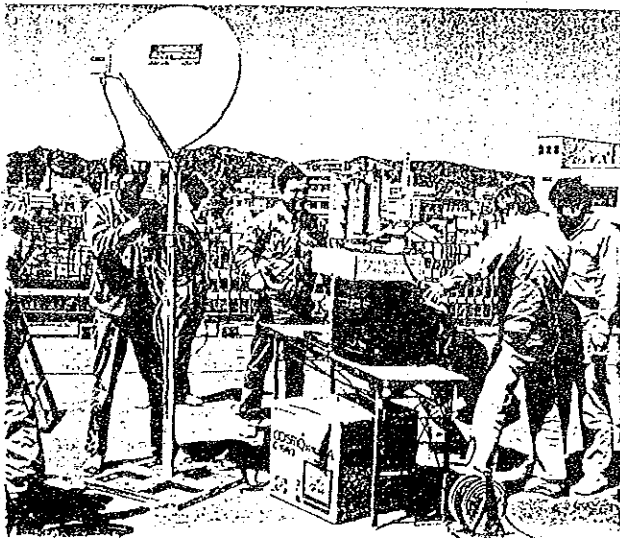
To popularize new broadcasting services, NHK has held public demonstrations of satellite broadcast reception throughout the country to inform the public about the advantages of such broadcasts.



Reception Counselling Car

Technical advice on reception methods is also provided as part of these events. Technical workshops on satellite broadcast reception for technicians at appliance stores and electrical contractors' shops have been organized throughout Japan to train specialist technicians in the new technology. NHK has also held public reception demonstrations and technical workshops for teletext and emergency-warning broadcasts, to increase the popularity of reception devices for these services.

As of December, 1986, some 120,000 households in Japan were equipped for satellite broadcast reception. In addition, according to a survey by the Electronic Industries Association of Japan, as of December, 1986, manufacturers had shipped some 22,000 teletext receivers and 39,000 emergency-warning broadcast receivers.



Technical Workshop on Satellite Broadcast Reception

Exorcising Ghosts

Ghost images are the most serious problem besetting good television reception. NHK has planned a variety of countermeasures to do away with ghosts. First, it is necessary to specify the building that is the cause of a particular ghost image problem. A location finder for TV ghost sources has been developed to determine the source of the problem; it can measure basic data such as the direction and distance of buildings causing interference, and desired/undesired signal ratios at the point of reception.

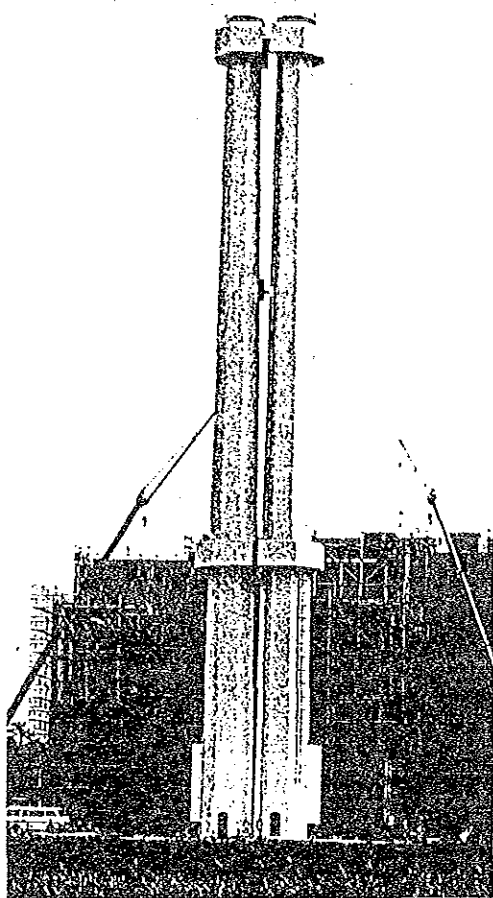
To reduce the reflection intensity of television

waves from high-rise buildings, the source of ghost images, NHK has also developed wave absorption panels of ferrite. These panels are now in practical use, attached to buildings at eight sites where they help to prevent of image degradation due to reflection. Prospects are good for their use on more buildings in the near future.

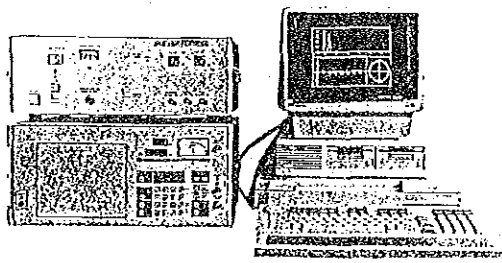
Another technique involves use of a super high frequency (SHF) translator station. If the presence of rivers, railroads, or other obstacles would make installing CATV difficult in urban areas with poor reception, using the SHF band can rectify the problem. SHF stations are now in use at two sites, in Tokyo and in Aichi Prefecture.

CATV Systems

NHK has also established CATV facilities for poor reception areas. A high performance antenna is set up at the spot with the best reception, and the TV signals it receives are amplified and distributed to the participating households over coaxial cable. With trunk amplifiers inserted every 300 meters along the cable, lengths of the trunk cable for these CATV systems range from 500 meters to 20 km, with 5.5 km the average. There were, as of 1986, 11,000 such CATV systems in operation serving 780,000 participating households. CATV subscribers account for about 2.5 percent of NHK reception contract holders.



Absorption Panels Attached to a Tall Chimney



Location Finder for the Sources of TV Ghosts

Regional Broadcasting

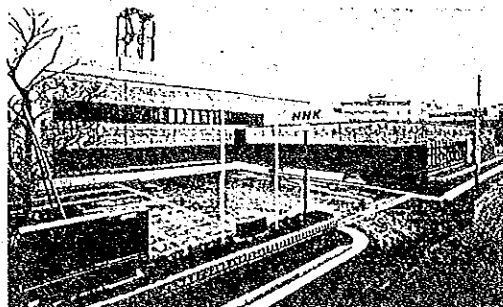
NHK transmits programs from the Tokyo Broadcasting Center to viewers throughout Japan, but that is not the whole story. NHK regional broadcasting brings people outside the capital region local news closely related to their lives. Regional broadcasting stations also contribute significantly to regional culture and community welfare by producing and broadcasting their own local programs.

To support this regional broadcasting, NHK has established 69 broadcasting stations throughout Japan, located in each prefectural capital and in other major cities. Those stations gather news and produce local programs. The news reports and programs are broadcast within the home prefecture and *may also be sent out to other stations for transmission throughout the country or within a regional block.*

Regional Services

Regional broadcasting stations operate transmitting stations for each of the five services: the two television services, two AM radio services, and FM radio. The regional stations are responsible for ensuring the reliable functioning of approximately *a hundred transmitting stations and relay stations.*

All stations throughout Japan are linked with the Broadcasting Center in Tokyo in a program network using circuits leased from Nippon Telegraph and Telephone Corporation (NTT). Thus the regional stations can transmit programs that

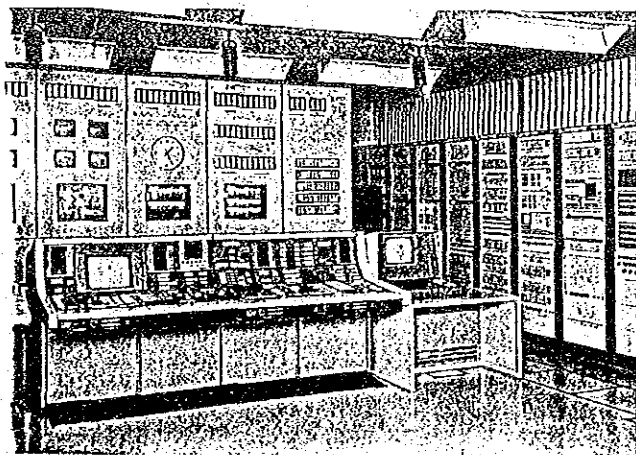


The Niigata Station

originate in Tokyo on their own stations' frequencies. The network also makes it possible to transmit locally produced programs throughout the country. *Regional block broadcasting and program exchange among regional stations is also possible over this network.*

To ensure the effective functioning of the network, NHK has adopted the broadcast program transmission control (BTC) system. In this system, a media identification signal (I signal) is always superimposed on the program signal for automatic detection of the type of medium, the signal level, and any malfunctions in the transmission path. A switching control cue signal (Q signal), sent out at the beginning and end of each program, controls the timing of program switches between stations for smooth program operation.

The master control facilities at the regional stations, including the BTC system, have full operational control responsibility for the reception of network programs, the transmission of locally produced programs onto the network, and the local broadcasting of locally produced programs. The facilities are micro computer controlled so that changes or additions to scheduled programs are made easily by striking the appropriate keys while watching the information display board and monitor. Moreover, self diagnostic devices check the entire system every minute or two for malfunctions and, while the data logger records the details of the source of a malfunction, the information is also displayed on wall monitors to speed up malfunction discovery and recovery.



The Master Control Room of a Regional Station

Program Production

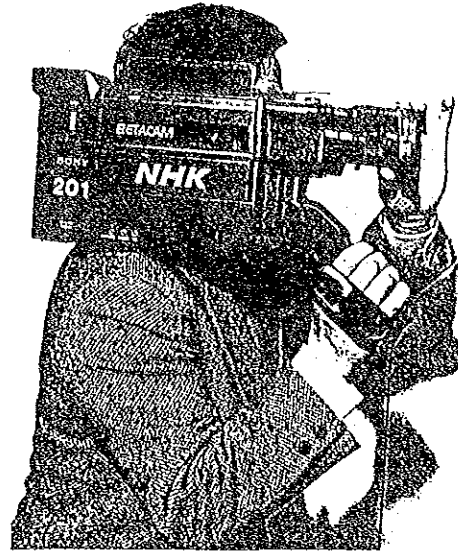
At the regional stations, integrated VTR-cameras, mainly in the Betacam format, are used in covering the news. The news studios at these stations are equipped with compact VTRs and remote-controlled cameras and switching controllers. Remote-controlled cameras are also used outside studios on the roofs of the broadcasting stations and in other spots with good visibility, such as on top of transmitting towers.

Regional stations have studios for both TV and radio program production. The cameras are used both for programs produced in the studio and for outdoor programs, and the VTRs are mainly in M11 format. Among the program production facilities are video effectors, electronic text and graphic generators, still picture files, and other devices using computer and digital technology.

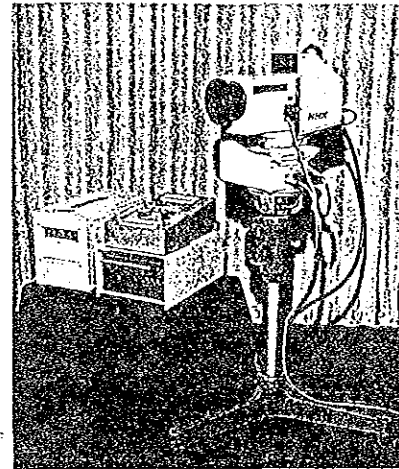
OB vans are used at regional stations for both program production and news reporting. They are equipped with two to four compact video cameras, video switchers, VTRs, and FPU transmission devices. In addition, regional stations have ENG/EFP vehicles and radio news cars.

Other communications circuits are, like the program transmission circuits, leased from NTT and form a communications network linking together

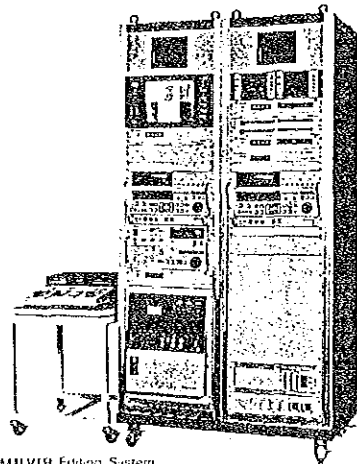
all the broadcasting stations in the country. This unique automatic switching network is multipurpose, used not only for the telephone but also for facsimile devices, still picture transmission, and data transmission. It also serves as reserve circuits should the audio program circuits malfunction. Thus, the communications net plays a crucial role in NHK's nationwide broadcasting system.



Integrated VTR-Camera

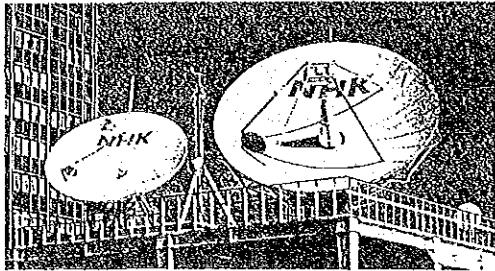


Compact Color Camera with Remote Controller for a News Studio



M11 VTR Editing System

Satellite Broadcasting System



Direct Broadcasting Satellite Transmitting/Receiving Antenna

On 23 January 1984, BS-2a, and on 12 February 1986, BS-2b were launched into stationary orbit 36,000 km above the earth at a point where the 110°E line of longitude crosses the Equator. Satellite broadcasting with BS-2a began on 2 May, 1984. After numerous technical experiments and multiple checks had been completed, experimental broadcasting on two channels from BS-2b began on 25 December 1986.

Characteristics of Satellite Broadcasting

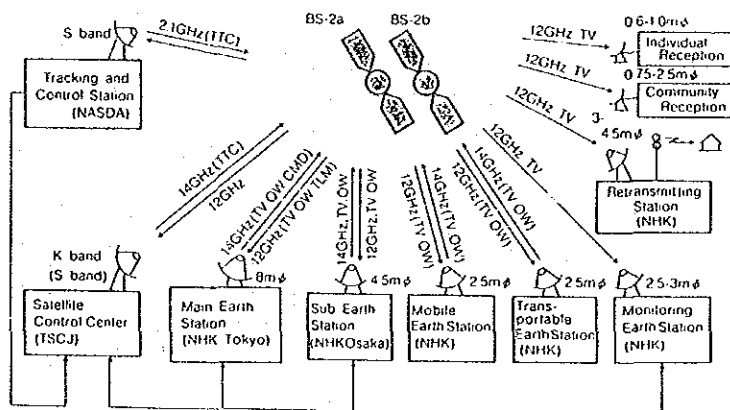
The BS-2 satellites each have two transponders, which receive signals carrying programs from an earth station and retransmit them suitably amplified directly to homes throughout Japan equipped to receive satellite broadcasts; a 12GHz-band antenna, which focuses the beam in the direction of Japan; solar panels, controlled to remain facing the sun; and devices to control the position and altitude of the satellite.

Satellite broadcasting makes use of the super-high frequency bands and is able to completely cover the whole of Japan. Moreover, as the signals reach the ground directly from above, there is nothing to block their path. Images are therefore received clearly, free from the problem of ghosts, and combined with the clarity of PCM sound produces outstanding reception.

Taking advantage of these benefits of satellite broadcasting, it is now possible to bring clear signals into homes on the many remote islands scattered throughout Japan's waters, in mountain areas where television is difficult to pick up clearly, and in city areas where there are many large structures. Then again, in times of earthquakes or typhoons, when terrestrial stations are unable to function, disaster bulletins and such can be broadcast without interruption.

For reception of satellite broadcasts, it is necessary to have a parabolic antenna, a BS converter, and a BS tuner. The diameter of the parabolic antenna for use in Honshu and Shikoku is about 75 cm. For Hokkaido and Kyushu, the diameter must be approximately 1 meter. On isolated islands, however, antennas of 3-meter class are necessary in some places, and in such locations, retransmission stations are set up to receive the satellite signals and convert them down into VHF band signals for retransmission to household receivers.

BS-2 Satellite Broadcasting System



Satellite Transmission System

(a) Television Picture

Television system Video frequency bandwidth Type of modulation Frequency deviation of carrier Pre-emphasis Frequency deviation of carrier by energy dispersal signal, symmetrically triangular, with frequency of 15 Hz RF bandwidth	525-line/NTSC system 4.5 MHz FM 17 MHz p-p CCIR Rec. 405 600 kHz p-p 27 MHz
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(b) Television Sound and Data

Parameter	Mode A	Mode B
Coding (PCM)		
Sound signal bandwidth	15 kHz	20 kHz
Sampling frequency	32 kHz	48 kHz
Quantizing and companding	14/10 bits, near instantaneous companding (5 ranges)	16 bits linear with range code
Sound emphasis	50/15 μ s	
Multiplexing		
Bit rate	2.048 Mbits/s	
Number of sound channels	4	2
Additional data capacity	480 kbits/s	240 kbits/s
Modulation		
Modulation method of subcarrier	4 μ -DPSK	
Subcarrier frequency	5.727272 MHz	
Frequency deviation of main carrier by the subcarrier	\pm 3.25 MHz	

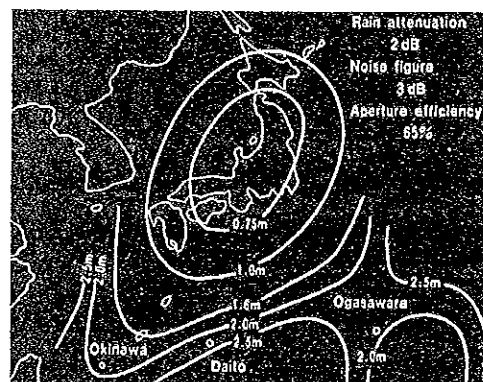
Terrestrial Facilities

For the transmission of programs to the broadcast satellites, terrestrial facilities have been established in Tokyo at the NHK Broadcasting Center, the main earth station, and in Osaka, a sub earth station. In addition, there are mobile earth stations that can move to any part of the country and relay broadcasts, and which in particular show their capabilities in times of emergency for news flashes. Transportable stations that are far more compact and can be loaded on to small vans or helicopters have also been prepared. Thus, various kinds of satellite broadcast programs are now possible.

The main earth station transmits on the two television channels and also monitors the working state of the transponders on board the satellites and controls them. It monitors the state of reception and transmission at other earth facilities, gathers and processes all forms of data from them, and monitors signals from the satellites to ensure that these are being properly received in every part of the country.

During the late night hours, when satellite broad-

casts are off the air, various kinds of technical experiments are carried out: Hi-Vision transmissions, PCM sound broadcasts, still picture broadcasting, and such, to seek out and confirm the various capabilities of the satellites and the system. As we stand at the threshold of the age of satellite broadcasting, research and development continues in order to bring to reality an exciting new form of broadcasting.



Satellite Broadcasting Coverage by BS-2
(Contour lines show diameter of a receiving antenna).

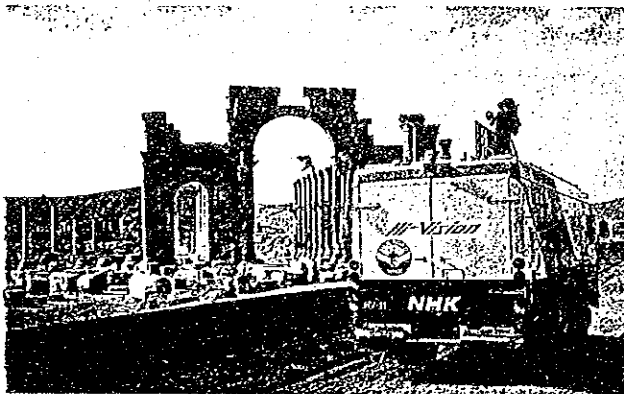
Hi-Vision System

Television for Tomorrow

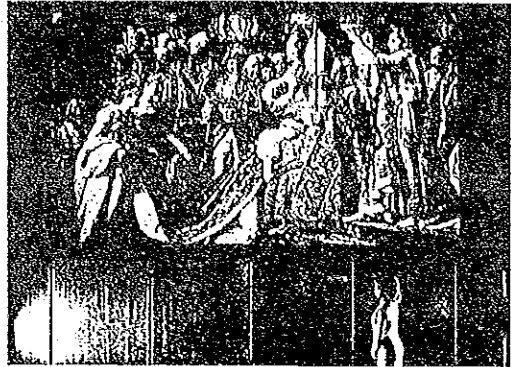
Hi-Vision (HDTV: high-definition television) has been the object of research and development by NHK since 1970 as the next generation television. It is a revolutionary system which displays finely detailed images on a large screen, and rivals the cinema in power and sense of immediacy. The basic parameters of HDTV were established on the basis of fundamental research into the characteristics of human vision and the psychological effects of large screens. It is expected that this new system will find a wide range of applications, not only in broadcasting but in other fields, including the various video-related industries, the cinema, printing, and photography. In order to develop it has an exciting form of television for tomorrow, NHK has been making an international appeal for a single worldwide HDTV standard. If it could be established, international program exchange and coproductions using HDTV would be easy. At the CCIR Plenary Assembly of May 1986, the HDTV

Proposal for a New Recommendation on HDTV Studio Standard

Number of scanning lines:	1125
Number of active lines:	1035
Field rate:	60.00 Hz
Scanning method:	2:1 interlace
Aspect ratio:	Horizontal 16 to vertical 9
Samples per active line:	1920 for luminance 960 for color difference



Hi-Vision Recording Van at an Overseas Location



Eidophor Display

studio standard shown in the table was discussed on the basis of a proposal tabled by NHK, and in the CCIR report on HDTV the proposal was included as the only one for the drawing up of a new recommendation. The NHK-developed system continues to be the leading candidate for selection as a single worldwide studio standard for HDTV.

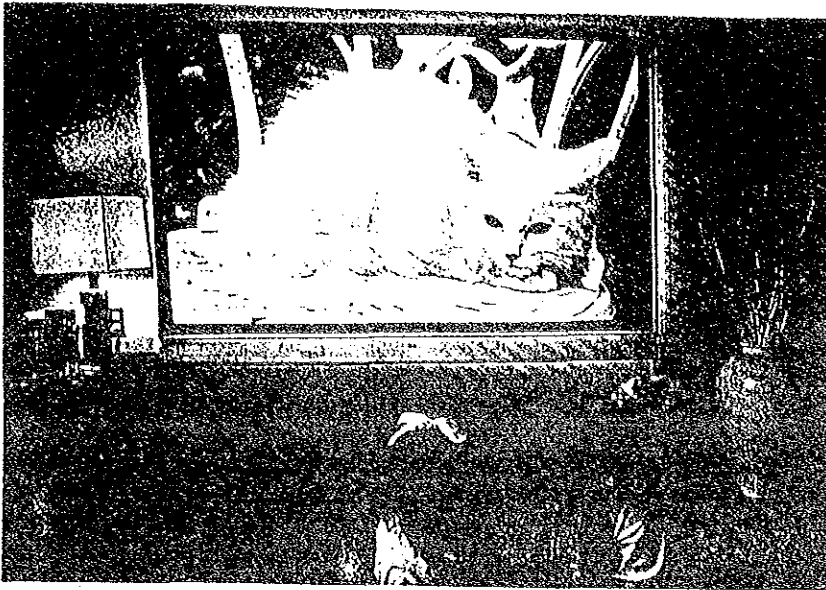
Hi-Vision Equipment

To date, NHK has developed the program production equipment and employed it for use in the production of Hi-Vision programs.

For outside Hi-Vision video shooting, there are one standard outside broadcasting van carrying two cameras and one VTR, and two small outside broadcasting vans basically equipped with one camera and one VTR, and in addition to these one set of video location equipment consisting of one camera and one VTR which can be transported to location sites when necessary.

At Studio CT-101, Hi-Vision program production can be made by means of an OB van, while in another studio a mobile-type video switcher has been placed for use in Hi-Vision program production work.

Video tape editing is being done in two standard editing rooms, each equipped with two one-inch VTRs and one video editor, and in an editing room equipped with two video playback units, and one video recording unit, as well as a chroma-key unit, and a digital video effector (DVE) capable of pro-



Living Room of the Future

ducing a whole range of video effects. The DVE for Hi-Vision use has the same level of capabilities as for existing television — reduction, enlargement and sliding of pictures — and at the same time is able to convert NTSC-format program material into Hi-Vision signals and synchronize them freely at any point on the HDTV screen.

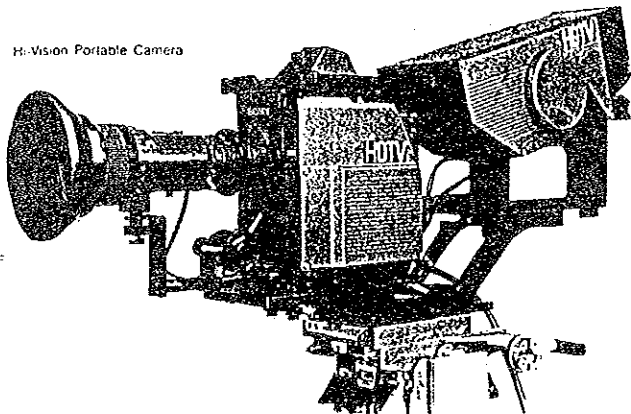
In addition to this equipment, there are a laser telecine converter and a laser film recorder for conversion between Hi-Vision and films, as well as conversion equipment to change Hi-Vision signals into NTSC or PAL/SECAM format so that Hi-Vision programs can be used for current television.

Hi-Vision Display

When Hi-Vision programs are produced, CRT displays of 26-inch to 40-inch size are commonly used, but for large-screen display projection type displays are employed. NHK produced a new Hi-Vision projector — Eidophor type — for a 240-inch screen. This can project images brighter than any other projector of the same class currently on the market.

MUSE System

In order to transmit Hi-Vision signals on a video signal bandwidth of close to 30MHz on a single satellite broadcasting channel, NHK has developed the MUSE (Multiple Sub-Nyquist Sampling Encoding) System band compression technique. The first experimental satellite broadcasts of Hi-Vision using this system took place in December 1986. In these experiments, excellent images and sound were received with a 75cm parabolic antenna, proving the practicability of applying MUSE to Hi-Vision broadcasting.



Hi-Vision Portable Camera

New Broadcast Media

Developments in electronics and telecommunication technologies have brought a variety of sophisticated new information media within close reach of practical application, and we can expect society to rely on them heavily in the coming years. Existing media and new media, wired and wireless technologies will be synthesized, influence each other, and, after a complex series of changes, emerge in a new system of a rich variety of information structures.

New broadcast and wired media can be expected to complement each other, amid social change and technological development, by supplying individuals with diverse and abundant information resources. Signs of the times can be seen in the recently implemented teletext services, and the introduction of satellite broadcasting to raise the technical quality of TV pictures and sound. Such

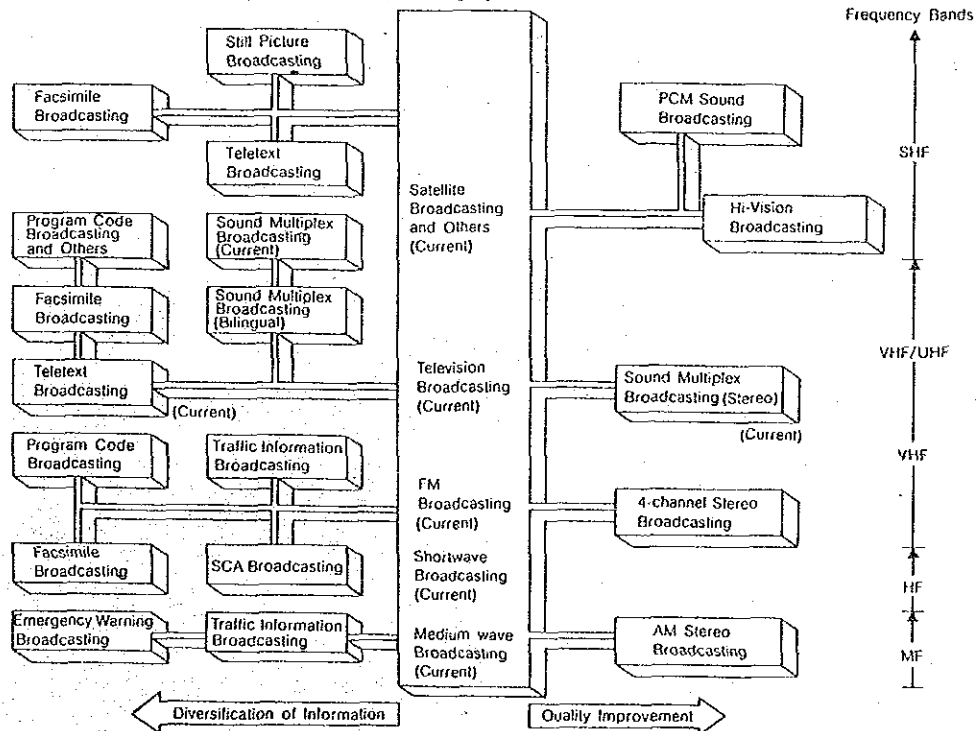
advances as high-definition television (HDTV) and the addition of pulse-code modulated audio to satellite broadcasts are also planned.

A satellite broadcast television channel has the additional capacity to transmit digitally encoded information other than television signal, on what is called its data channel. Research aimed at tapping these capabilities to provide a variety of information services is currently in progress.

Although direct satellite broadcasting in Japan is now undergoing trial operation in the 12 GHz band, future systems are expected to utilize the 22 GHz band. Integration with CATV services is also probable.

New combinations of broadcasting and telecommunications technology may appear, yet the broad popularity and unique sensory impact of television assure it a role as the focal point of a new

Current Broadcasting and Future Growth of Broadcasting Systems



video culture. In fact, the implementation of HDTV is expected to greatly heighten the importance of TV as an information medium.

Emergency Warning Broadcasting

In autumn, 1985, NHK initiated emergency warning broadcasting services. This system employs special sound signal for automatic actuation of designated radio and TV receivers so that the audiences will be sure to receive emergency information about major earthquake and other disasters.

Since the control signal is sent over ordinary radio and television frequencies, a similar technique could also be used to send program identification codes for particular types of programs — news or traffic reports, for example. A user who wanted to be sure, for instance, to receive the news could then preselect for its automatic reception.

Teletext

Teletext transmission involves multiplexing character and graphic data on television signals and then decoding and displaying it for the viewer. Many countries have already begun to offer teletext services, and NHK, having overcome the complexities involved in display of written Japanese, has provided teletext services in Japan since 1985.

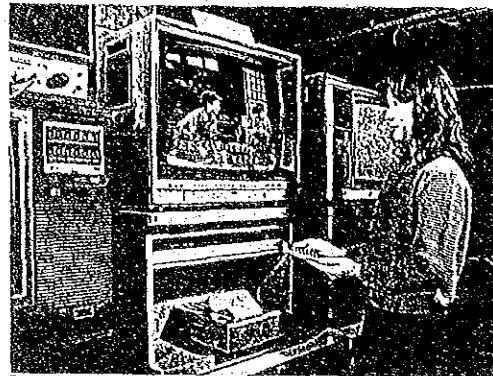
PCM Sound Broadcasting

A single satellite broadcasting channel can be used to carry up to 16 stereo audio signals employing pulse-code modulation to achieve the highest possible fidelity for music and other audio programming.

Still-Picture Broadcasting

This medium was developed to transmit 50 separate programs simultaneously within the bandwidth of a single conventional television channel. The viewer could select among the programs, each consisting of still pictures and accompanying audio track. The system is intended for educational programs and information services.

In Japan, still-picture broadcasting is envisaged



Reception of a Japanese-language Teletext Broadcast

as an effective means of utilizing limited satellite broadcasting channels, and one which is amenable to development under the new high-definition TV standard. NHK is also investigating the suitability of this medium for educational programs in one of Asian countries, where NHK would provide the necessary technical assistance.

Digital Data Service

Multiplexing method would be used to transmit digital codes for various kinds of information within the digitally encoded audio channel of a satellite broadcast channel. Research is underway at the Laboratories on transmission formats for services to utilize that data channel, including a facsimile service that would deliver documentary information with service identification codes to permit selective print out or tele-software that would provide programs and data for personal computers, and tele-music for automatic performance by their synthesizers or electric pianos.

VHF/FM Multiplexed Broadcasting

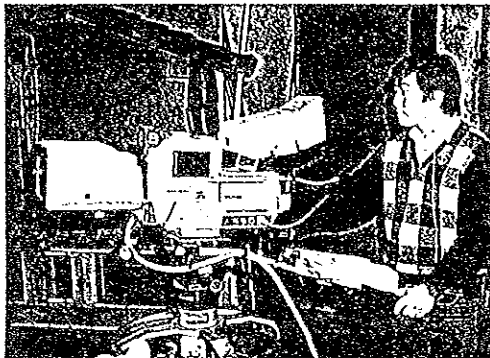
NHK is currently investigating methods of multiplexing documentary data and other digital information within its FM radio broadcasts, without interference on conventional stereo reception. This medium is seen as meeting domestic conditions in the use of VHF-FM radio; such multiplexing systems in other countries would be a matter for separate development.

New Technological Developments

NHK constantly works on the development of new technology to supply richer forms of expression to its programs and ensure stable broadcasting.

Latest Television Cameras

There must always be rapid adaptation to the various demands of directing in program production. Mindful of this, NHK has developed a new, small, high-performance color camera that can be used both as a standard camera and as a hand-held camera. It is equipped with a micro computer-controlled auto-setup function, so that the amount of time and labor spent on routine adjustment



Color Camera for Studio Use



Hand-held Color Camera

has been reduced. Moreover, as a magnetic-focus, static-deflection type 2/3-inch MS Salicon is employed for the pickup tube, picture quality is equal to that obtained with a large, standard camera. There are two models of the new camera: one for use in studios with conventional, multicore cable; and the other for outside broadcasting, for use with triaxial cable, and equipped with a small, lightweight telescopic lens. The latter is easy to set up and dismantle and is highly rated for its outstanding mobility and high performance.

In addition to this, a charge-coupled device (CCD) camera, which makes good use of the high sensitivity and low power CCD device, has been developed for news gathering work and is now in use.

Standard Television OB Van

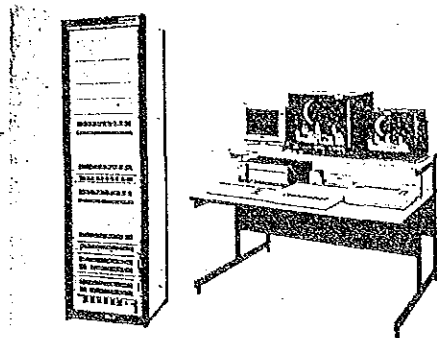
Small size (chassis length approximately 5 meters), highly mobile television OB vans equipped to carry up to five TV cameras have been distributed to local broadcasting stations.

Electronic Graphics Generator

For news, sports and weather forecast programs, the rapid and easy generation of attractive diagrams, graphs, characters and other graphic displays is necessary. In order to obtain effective image displays, it is also necessary to be able to alter diagrams, select colors, adjust the position and size of diagrams freely and generate as many as 7,000 characters in various combinations and styles. In order to meet these various requirements, NHK has developed an electronic graphics generator. By means of drawing on a tablet and



Compact OB Van



Electronic Graphics Generator

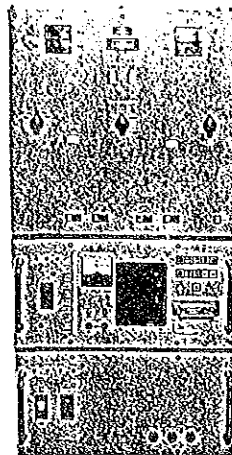
manipulating function keys, the different forms of producing displays — the drafting, altering, and the animating of diagrams and characters — can be done quite easily. The equipment also make it possible to receive weather and meteorological data from the Meteorological Agency or data on various sports events input from outside the station, and generate characters and diagrams automatically.

Generators have been installed in all NHK broadcasting stations throughout the country and are being used for news, sports weather reports and other programs.

Portable 1kW Medium Wave Transmitter

The broadcast media play a critical role in times of emergency and disaster. NHK, as a designated public organ under the Basic Law on Measures to Deal with Disasters, has given considerable attention to ensuring that its broadcasts will continue in times of emergency or disaster. Medium wave broadcasting is a particularly important medium, as the diffusion of transistorized receivers shows. At NHK, in preparation for the possibility of damage being sustained by its broadcasting facilities, a small, lightweight, fully solid state, portable, medium-wave transmitter has been produced.

The transmitter contains a newly developed static induction transistor (SIT) power amplification device in its amplification section. Four of



Portable 1 kW Medium-wave Transmitter

these SITs give it an output of 1kW. The SIT has similar characteristics to the electron triode, and moreover its power capacity is more than five times that of the metal-oxide semiconductor field effect transistor (MOSFET) in present use. Its development has made possible the transistorizing of this high-output transmitter.

Interference Suppression Unit

In recent years, with the growing expansion of television and FM radio broadcasting in neighboring countries, television broadcasting in Japan has been experiencing increasing interference caused by sporadic E-layer or duct induced anomalous propagation. NHK has been working hard to exclude this and to ensure the delivery of clear television images to the nation's homes. One part of this work has been the development of an interference suppression unit. This is now being used by some NHK television relay stations.

The suppression unit extracts the interference wave component from the incoming signal waves and, by resynthesizing it with the incoming signals, suppresses the interference waves. As this work is controlled by a high-speed microprocessor, it can effectively suppress a large number of complicatedly changed waves. The unit is inserted in the intermediate frequency stages of the relay broadcasting transmitters, suppresses the interference component waves mixed with the incoming waves, and retransmits clear, unadulterated signals.

NHK Science and Technical Research Laboratories

An NHK laboratory for research into broadcasting technology was established in 1930, five years after the start of radio broadcasting in Japan. Growth followed, and today it stands as the Science and Technical Research Laboratories, still playing a leading role in the progress of broadcasting technology, not only in Japan but in the world as a whole.

History

In the earliest days, a staff of 16 pursued studies in such areas as the acoustic design of studios and the development of a domestic radio receiver, although dependent upon technology from more advanced countries. In 1937, with the Tokyo Olympic Games scheduled to open in three years' time, it was decided that experimental television transmissions should be made of the Olympic events, and research and development on television broadcasting was initiated. With the start of the Second World War, however, both the Olympic Games and television research were suspended, and the launching of Japanese TV broadcasting was delayed until 1953, eight years after the end of the war.

From then on, the progress of broadcast tech-

nology in Japan was rapid, and with the 1964 Olympic Games in Tokyo, NHK's technology was on a level with that of the other advanced countries. Progress in innovative developments such as direct broadcasting by satellite (DBS) and high-definition television (HDTV) followed.

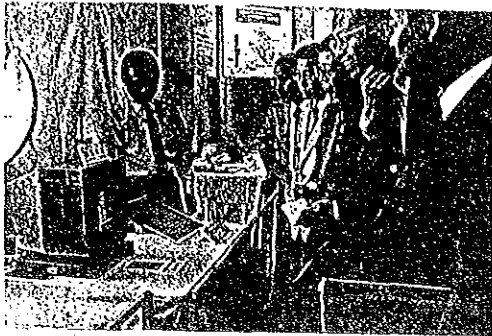
The Laboratories' staff of some 350 now work on the improvement and development of both equipment and technical systems for broadcasting applications, and the development of new media for the future, as well as on fundamental research aimed at the further progress of broadcast technology.

Satellite Broadcasting

For DBS, which is regarded as the transmission medium for future HDTV and PCM sound broadcasting, NHK is using the 12 GHz band for experimental service of NTSC television signals. At the Laboratories, research is being conducted on technology related to satellite-mounted transponders, antennas and altitude control equipment for future progress in such aspects as increasing the number of channels, boosting transmission power and use of the 22 GHz band. In addition, in order to make use of satellites more effectively and,



NHK Science and Technical Research Laboratories



The Laboratories Open to the Public

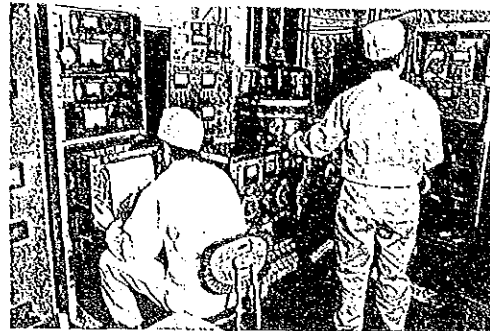
moreover, more economically, research is under way on data broadcasting using data channels, in areas such as forms that services will take, coding of signals, and methods of transmission.

Refining HDTV

Research into HDTV began at the Laboratories nearly 20 years ago, and the basic development of equipment is now finished. The first steps are being taken toward practical application. Research is still continuing, however, on the development of large-size flat panel displays needed for home HDTV receivers, on improving the performance of cameras to make production work casier, and in many other areas.

With HDTV, the digitizing of video signals in studios, and other developments, the amount of information required for image display in the future will increase by leaps and bounds, so that technology for high-density recording with VTRs and video memories will become necessary. In addition, transmission systems within broadcasting stations will also need large capacities. In preparation for future changes of this nature, the Laboratories are developing devices for optomagnetic recording and perpendicular magnetic recording and pursuing studies on signal transmission by means of optical fiber cables.

Digital techniques have brought revolutionary changes to recent broadcast technology. Research is now under way on ingenious forms of digital image processing and computer graphics that will



Dust-free Workshop for Rebuilding Saticons

enable dark object images and imaginary scenes, that cannot be dealt with by the camera alone to be produced directly in the CRT.

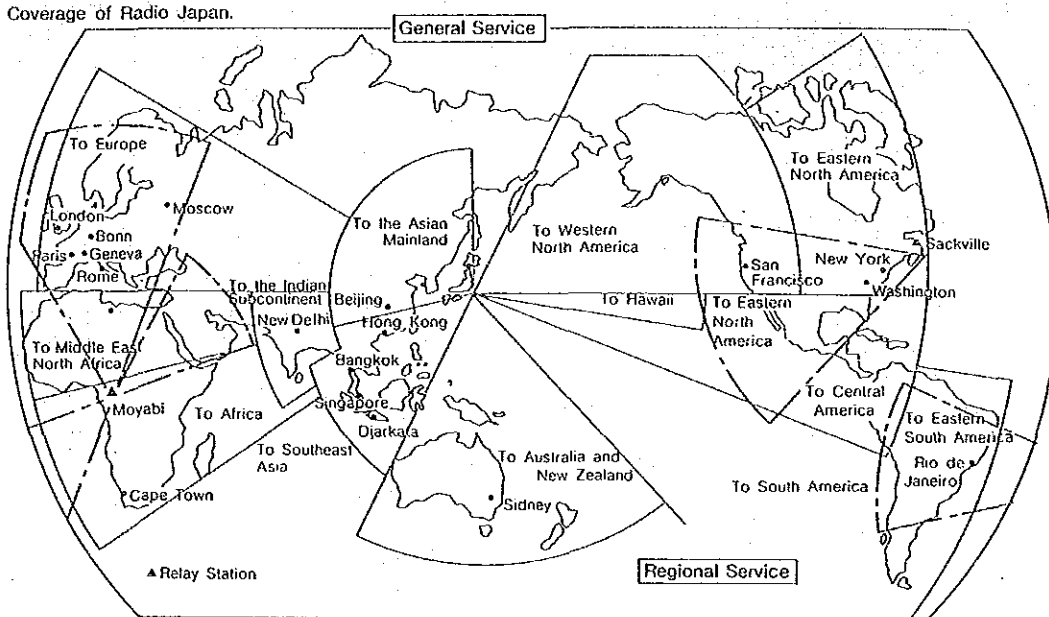
Comprehensive Approach

A distinctive feature of research at the Laboratories is that it takes in the whole field of broadcast technology — from the stage at which the signals are picked up by cameras and microphones, through program production, recording and transmission, and signal transmission by radio waves; to, at the receiving end, the reproduction of image and sound, and the recognition of information through the ears and the eyes — and studies it in balanced manner. A typical example of the results obtained can be seen in HDTV.

Emphasis is also placed, therefore, on areas of fundamental research. The most important work in this field is being done on human perception of images and sound, the mechanism by which the nervous system processes information, and the trial product of a self-learning pattern recognition unit, the Cognitron.

Recent progress in electronics grew out of the solid state physics that produced the transistor. Today, opto-electronics is on the threshold of building a new age. Efforts at the Laboratories are now being directed to LSI and opto-ICs, and other such items for use in future broadcasting equipment, crystal growth in compound semiconductors by molecular beam epitaxy, and the development of digital filters for image processing.

Overseas Broadcasting Service



The work of Radio Japan, NHK's overseas broadcasting service, is to bring its listeners up-to-the-hour news of Japan and the world, to introduce the culture, economy and industries of Japan to the people of the world so as to give them a better understanding of the nation, and at the same time to supply accurate information and varied entertainment to Japanese living and working overseas.

Radio Japan

At present, Radio Japan broadcasts in 21 languages for a cumulative daily total of 40 hours of broadcasting time. The service can be divided broadly into the General Service, which transmits in Japanese and in English to the whole world 20 hours a day, and the Regional Service, which divides the world into 18 regions and broadcasts to each in the appropriate languages for a total of 20 hours a day.

The number of programs transmitted by Radio Japan amounts to a weekly total of 1,600. This huge number of programs has to be sent out in the various languages, at the various transmission

One Day at Radio Japan: Program Hours, Regions Served by Broadcasts, and Language Used (as of 1997)

Program	Program Hours Daily	Region Served	Languages
General Service	20	Entire globe	English, Japanese
Regional Service	20	18 regions	21 languages, including English, Japanese, and Chinese
Total	40	18 regions	21 languages

times and over the correct transmission systems without a single error, and because of time zone differences without a pause throughout the 24 hours of the day. A computerized automatic system is therefore used.

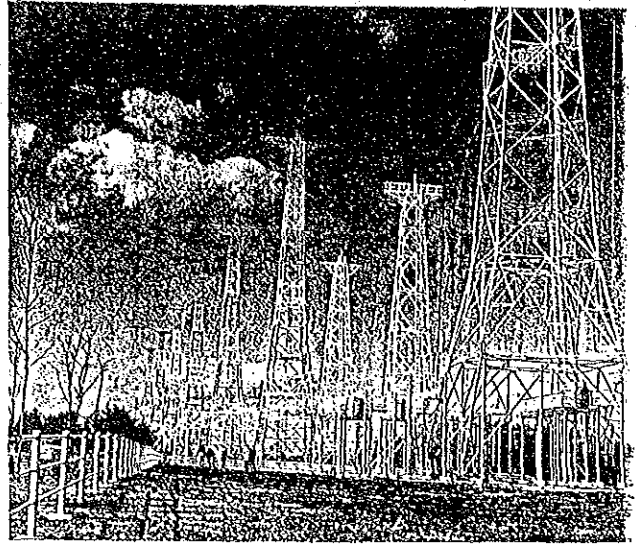
Transmitting Station and Relay Stations

The programs of Radio Japan, broadcast from NHK, are sent out through an exclusive circuit to Yamata Transmitting Station of KDD (Kokusai Denshin Denwa Co. Ltd.), approximately 60 km north of Tokyo. From the short wave transmitters the programs are transmitted to the various regions of the world. Stable reception of these broadcasts is possible in neighboring countries

on the Asian continent and in Oceania or the western regions of North America, but for more distant areas such as Europe, Africa and Central and South America, reception may at times be less stable due to such factors as interference. NHK has therefore been working since 1984 on a 4-year scheme to expand and consolidate its facilities at the Yamata Transmitting Station, with the cooperation of the government and KDD. It is also using a relay station in Moyabi in Gabon to transmit to Europe and the Middle East, and one in Sackville in eastern Canada to transmit to areas in North America.

Short Wave Transmission

Short wave transmissions are widely utilized for both overseas and domestic broadcasting in many countries throughout the world. Consideration must therefore be given to the frequencies employed. NHK makes full use of computers to select the frequencies that are most suitable for the propagation of radio signals and free of interference for its various service areas. NHK has made detailed studies of the best frequencies, based on calculations of signal-to-interference ratios and reception field strengths, but the selection of channels that are clear and entirely free from interference has been growing more difficult year by year.

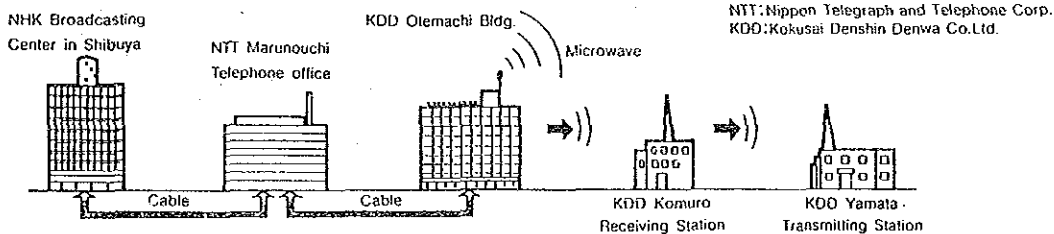


KDD Yamata Transmitting Station

Summary of Planned Upgrade of KDD Yamata Transmitting Station

	Transmitters	Aerials
Old	100 kW.8 50 kW.2	Rhombic antennas:36 Curtain antennas:6 Log-periodic antennas:4
New	300 kW.4 100 kW.4	Curtain antennas:13 in 21 directions Log-periodic antennas:4 in 4 directions
Features of the New Equipment	Two of the 300 kW transmitters use pulse-duration modulation (PDM)	A single curtain antenna can transmit in two or three directions using beam reverse and beam slew

Radio Japan Transmitting System



Radio Japan Relay Stations

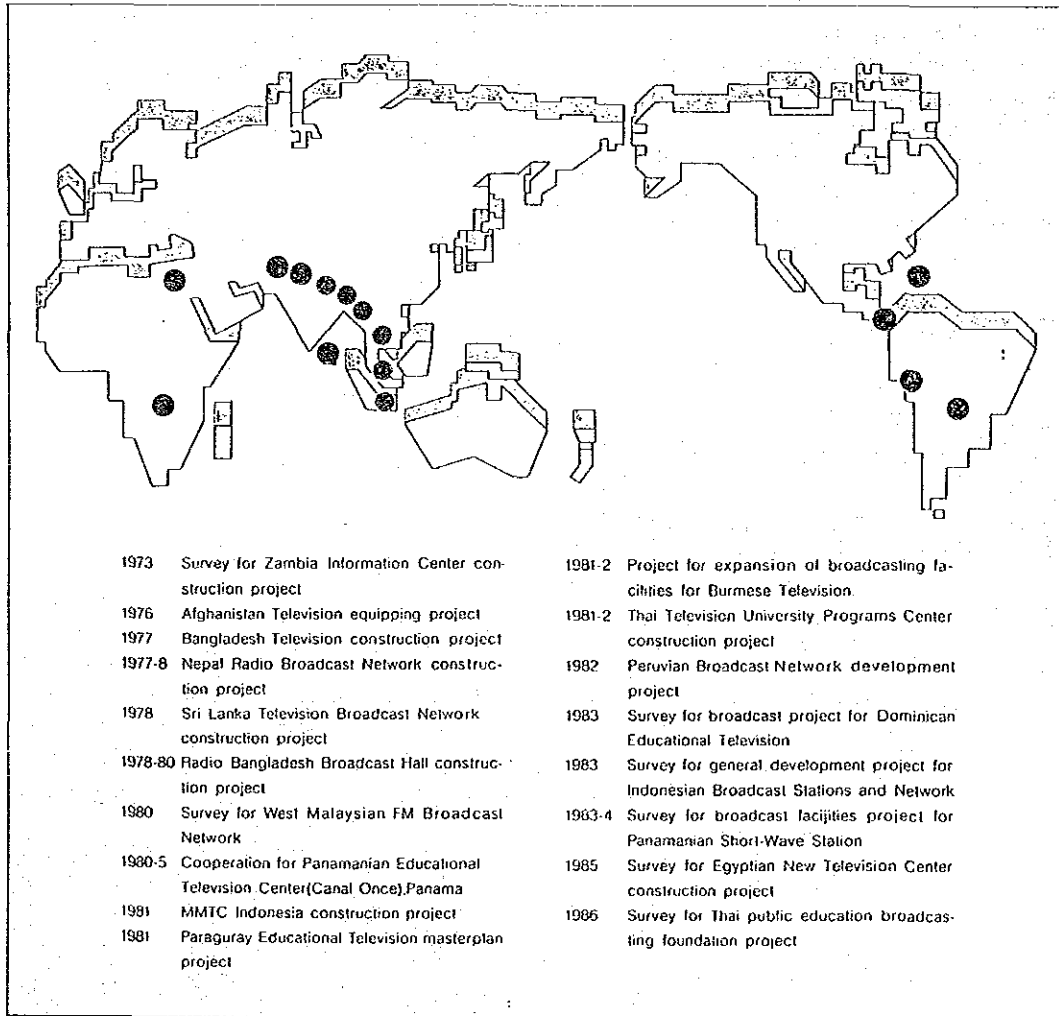
Relay	Broadcasting Station	Date Started	Region Served	Output	Programming and Hours
Gabon (Moyabi transmitter)	Africa No. 1	2 April '84	Europe, Middle East, Eastern South America	500 kW	General Service, 8.5 hrs., Regional Service, 3 hrs.
Canada (Sackville transmitter)	Radio Canada International (RCI, the international department of the CBC)	1 Oct. '86	Eastern North America	250 kW	General Service, 4 hrs.

International Cooperation

The development of communications and transportation networks has greatly increased the exchanges of information and people between nations. In consequence, international exchanges in the broadcasting field have become extensive. NHK engages in a wide range of cooperation that includes collaboration with broadcasting organiza-

tions in program exchange, coproductions and coverage cooperation, as well as participation in the activities of such organizations as the ABU, EBU and OIRT, taking part in international conferences, such as those held by the CCIR, and giving technical assistance to developing countries.

International Cooperation in Surveys Relating to Broadcasting Development or Facilities Design or in Broadcasting Projects
Major Cooperative Activities, 1973-1986



Sharing Know-How

In the field of broadcasting technology, NHK's cooperation takes the form of presenting research reports at international conferences and academic meetings, and technical cooperation in response to requests from other countries. NHK has also played its part in the global diffusion and standardization of broadcasting technology by participating in the activities of the CCIR, contributing for many years the results of its latest technical studies. NHK has recently been working energetically for the establishment of unified standards for HDTV. At the international conferences on the allocation of broadcasting frequencies, NHK has taken part in the deliberations, and supported the position of an impartial allotment.

Technical Assistance

As the leading broadcaster in Japan, NHK is active in providing technical assistance on the basis of diplomatic relations with other nations. The range of its activities in this role is wide,



On the Spot Training of Program Production



Technical Assistance at Zambia Broadcasting Service

and takes in such things as surveys and planning for expansion projects for broadcasting networks, surveys aimed at improving the equipment of broadcasting facilities, the dispatching of technical experts, and providing instruction on broadcasting technology to engineers of broadcasting organizations coming from abroad. The nations to which NHK extends such assistance are numerous, and include many in Asia, Africa and Central and South America.

Towards Closer Cooperation

There is also technical cooperation based on agreements between NHK and overseas broadcasters. In particular, NHK carries out technical exchanges of a close nature with organizations in neighboring countries, such as Korea and China. This is done to pass on new broadcasting techniques by dispatching technical experts as lecturers or by receiving study groups. Today, when the world's news is disseminated in the same way as domestic news, broadcasting organization all over the globe should grow together, side by side. In the hope that this ideal will become reality, NHK continues its program of technical cooperation.

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JICA