Source: Sound and Vision Spring 1971

A U.H.F NETWORK FOR THE SWEDISH SECOND TELEVISION PROGRAMME

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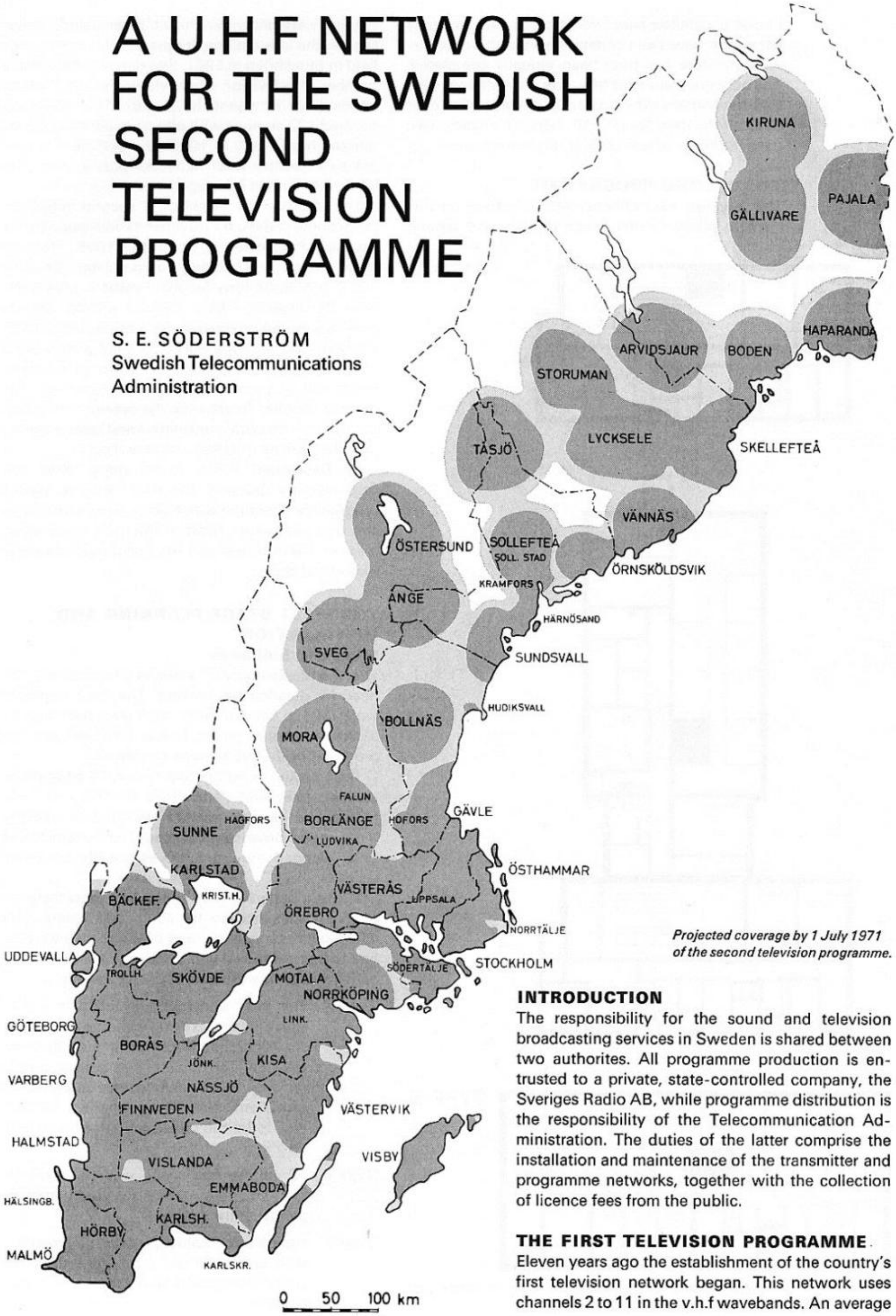


Projected coverage by 1 July 1971 of the second television programme.

INTRODUCTION

The responsibility for the sound and television broadcasting services in Sweden is shared between two authorites. All programme production is entrusted to a private, state-controlled company, the Sveriges Radio AB, while programme distribution is the responsibility of the Telecommunication Administration. The duties of the latter comprise the installation and maintenance of the transmitter and programme networks, together with the collection of licence fees from the public.

THE FIRST TELEVISION PROGRAMME

Eleven years ago the establishment of the country's first television network began. This network uses channels 2 to 11 in the v.h.f wavebands. An average of one transmitter plus two transposer installations per month have been commissioned and a country-wide network has now been virtually completed. The network comprises fifty-one main stations plus 126 transposers which provide coverage for over 99% of the population. All stations employ two transmitters to ensure programme continuity.

THE SECOND PROGRAMME

The Swedish v.h.f channel allocations are insufficient to allow for the establishment of a second national network within the v.h.f wavebands. However, at the international frequency plan conference held in Stockholm in 1961, Sweden was allocated a number of television channels in the u.h.f wavebands (that is, channels 21–68). This allocation covered 123 stations with effective radiated powers ranging from 20kW to 1000kW – sufficient to permit two country-wide networks plus a third network with limited coverage.

The decision to establish a second television programme in the u.h.f wavebands was made by the Swedish Parliament in December 1966. The first stage, which is scheduled for completion by June 1971, comprises forty-six main stations plus eighteen transposers. These stations should provide coverage for approximately 95% of the population. The sixty-four stations will be co-sited with existing v.h.f first-programme stations, utilizing the same masts and, in some cases, the same buildings. Additional facilities to enhance the network reliability, for example, standby transmitters and reserve power supplies, will be installed at a later date.

In December 1969, three years after the parliamentary decision, the u.h.f network started programme operation with twenty-nine transmitters and one transposer. Most of the main transmitters were of 40kW power and the population coverage was about 80%.

THE FIRST STAGE PLANNING AND INSTALLATION

Sites and buildings

The use of existing v.h.f stations sites obviated the need for detailed site surveys. The main problems were thus to provide from such sites the required effective radiated power (often 1000kW) and the provision of the programme connection.

The existing buildings contained, in addition to the two television transmitters for the v.h.f first-programme service, six f.m transmitters carrying three sound broadcast services. The buildings had been planned around 1960 essentially for those services.

Within a period of four-and-a-half years forty-six of these sites had to be equipped, mainly with 40kW u.h.f transmitters, and of which twenty-nine had to be operational within three years. Four alternative solutions were thus adopted, namely:

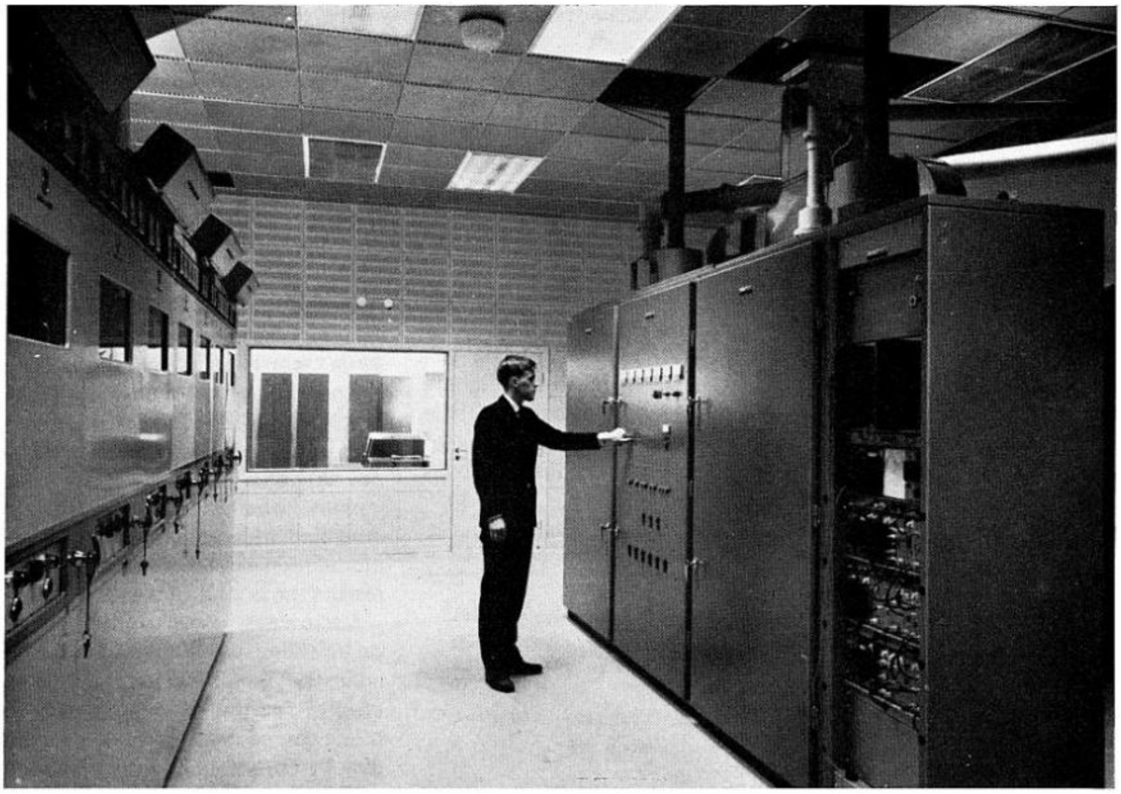
- 'Type K' The u.h.f transmitter installed in a free space in the existing building with constructional modifications limited to those essential for cooling and power supply facilities. This solution was intended as provisional only. The permanent solution was to be the construction of an annexe building.
- 'Type B' Where the free space was sufficient for two u.h.f transmitters, the first would be permanently installed.
- 'Type T' Here a new building would be erected – with space for six u.h.f transmitters of which two would be for the second programme.

TYPE K

TYPE T

TYPE N

The three types of transmitting station layout – the u.h.f transmitter is indicated by the black block.



A Marconi 40kW u.h.f transmitter. The drive unit, sound amplifier, vision amplifier and control cabinets are in front with the h.t rectifier behind. The combining filter is on a floor below.

'Type N' Where the u.h.f transmitter could be installed in a 'late' v.h.f building which could be planned to house also four u.h.f transmitters.

The building schedule was as follows:

In operation by	*Provisional 'K' Type*	*Permanent 'B' Type*	*'T' Type*	*'N' Type*	*Total*
5.12.69	12	2	9	6	29
1. 7.70	4	–	–	–	4
1. 7.71	4	–	8	1	13
Total	20	2	17	7	46

Power supplies and cooling

The power consumption of a 40kW u.h.f transmitter is approximately 190kW of which some 80% appears in the form of waste heat. Where the building was planned for u.h.f these requirements could be included at the planning stage. Where modified v.h.f buildings were to be utilized the existing mains, ventilating and heat exchanger facilities had to be replaced by equipment with the requisite additional capacity.

Programme distribution

The stations receive the various sound and vision programmes via microwave links. The second programme required the expansion of the existing facilities, although in the first stage it was possible to utilize the reserve capacity of the existing system.

Masts

The existing masts carrying the v.h.f aerials at all forty-six sites were initially designed, or could be modified, to mount also the u.h.f aerials. Thirty-six of these masts were between 300 and 335 metres high, seven were between 200 and 300 metres and the other three less than 200 metres.

The u.h.f aerial installation work had to be planned in conjunction with other site work due to the requirements of personnel safety. Building work was also restricted by the potential hazard of falling ice from the masts/aerials.

Transmitters

A television transmitter normally comprises three basic units – an amplitude-modulated vision transmitter, a frequency-modulated sound transmitter, together with a combining filter which combines the vision and sound transmitter outputs to a single output to the aerial. The vision transmitter frequency response has a vestigial-sideband characteristic which is complementary to the home receiver frequency response. Similarly the transmitter and receiver group-delay characteristics are complementary.

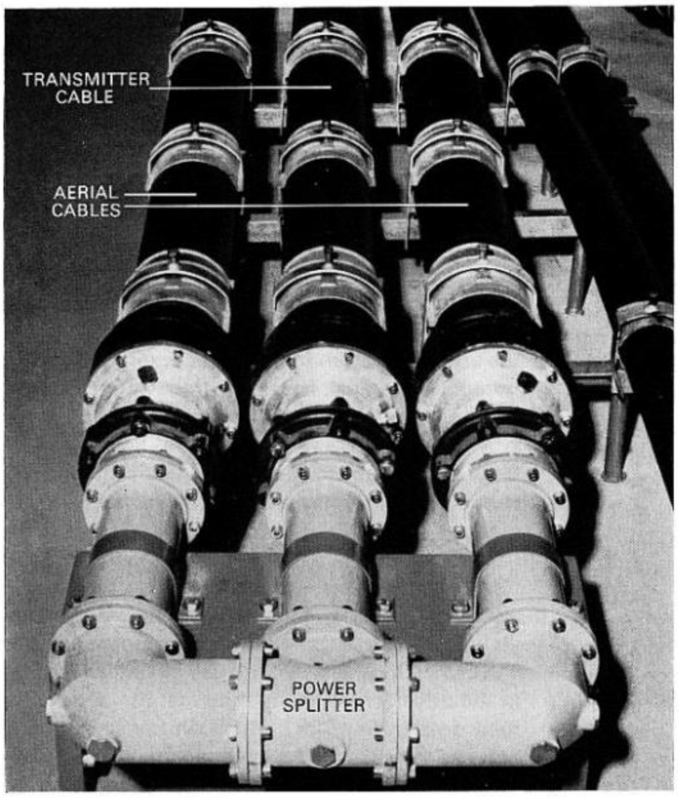
The relatively high frequency range of u.h.f television transmitters makes possible the use of microwave valves, for example high-power klystrons, in place of convential, grid-controlled valves. Such valves, and the use of semiconductors in the drive stages, enable the number of vacuum-tube devices in a u.h.f television transmitter to be reduced to two or three, even where the peak vision power is 40kW, or greater.

In the first stage forty-one transmitters having a peak vision power of 40kW were needed, together with five 10kW transmitters. Orders were placed for transmitters of the following types:

Quantity	*Vision power*	*Amplifier valve*	*Cooling*
49	40kW	Klystron	Vapour
2	10kW	Klystron	Vapour
2	10kW	Klystron	Forced air
2	20kW	Tetrode	Vapour
4	5kW	Tetrode	Forced air

The tetrode transmitters were chosen for two reasons. Firstly, it was desired to obtain experience with such transmitters and, secondly, some immediately available and easily installed transmitters were needed for early provisional stations. The table below details some of the design characteristics of the forty-nine 40kW transmitters supplied by three manufacturers.

Design detail	*Type (quantity)*
FINAL AMPLIFIER	
Vision Output Valve	4-Cavity Klystron (49)
Sound Output Valve	4-Cavity Klystron (49)
Cooling Method	Vapour (49)
INTERMEDIATE AMPLIFIER	
Vision Valve	TWT (28); Triode (13): None (8)
DRIVER STAGE	
Modulation	I.F (36); R.F (13)
Low-power v.s.b filler	I.F (36); R.F (13)
Group delay correction	I.F (28); video (13); video+I.F (8)
Amplifier linearity correction	I.F (36); video (13)
Differential phase correction	I.F (28); video (21)



The aerial power-splitting transformer. The transformer can be changed by a 'U' link to feed one half of the aerial.

The performance of all transmitters was checked after installation. As each station does not have complete measuring facilities, five sets of all the requisite instruments were transported for this purpose. To measure power output a water-cooled coaxial test load with flow meter and thermometers is included at each station – the r.f power being absorbed in the water which forms the dissipative element.

Transposers

A transposer is a receiver/transmitter which receives a u.h.f television signal on one channel, transposes the received signal to another channel which is then amplified for retransmission. It consists essentially of a receiver unit, a frequency transposing unit and an amplifier. Normally both vision and sound carriers together with the colour subcarrier are amplified in a common final amplifier. The intermodulation products formed by these three signals restrict the output power from such a transposer.

Microwave valves – klystrons for higher powers or travelling-wave tubes for lower powers – can again be employed in u.h.f transposers. Alternatively, for low-power transposers, a high-gain triode can be used, especially when it can be driven directly from a solid-state drive unit.

As all u.h.f channels have a constant 8MHz spacing, a single (common) frequency crystal oscillator may be used for all transpositions. This oscillator is followed by suitable synthesizing or filtering units to obtain the required mixer oscillator frequency. This method is particularly useful where a change of channel transposition may be needed.

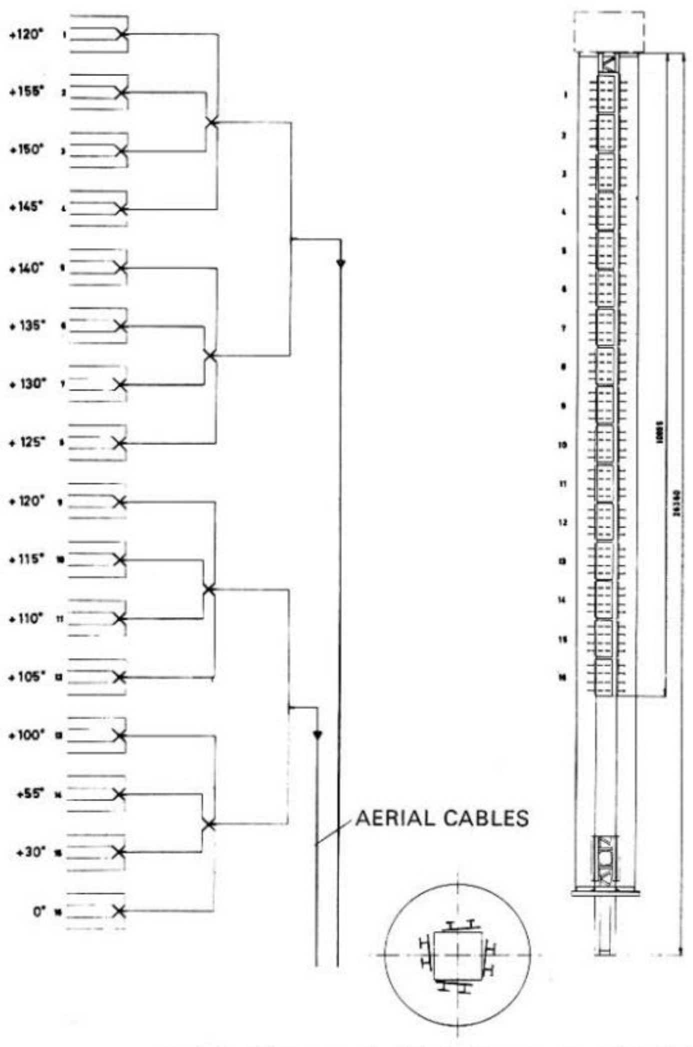
The need for transposers naturally occurs in the later stages of the installation programs. Twenty have been ordered to date all of which employ forced-air cooling. Ten have a vision power of 1kW and use a klystron amplifier. Two have a power of 200W and a further four of 50W and all employ travelling-wave tubes. The last four use a triode amplifier and have a 50W vision power.

Aerials and feeders

The u.h.f aerial system for each station is installed atop the mast and is protected by a plastic glass fibre cylinder. The aerial is divided into two halves each of which is fed from the station building by a 5-inch coaxial cable. The combining unit output is fed into these two cables via either a power splitter or a 3dB coupler, the latter to obtain insulation between the two halves of the aerial.

As most of the stations are planned for three u.h.f services eventually, all aerials have been designed to cover the frequency range 470MHz–850MHz. The feeder system has been designed to carry the power from three 40kW transmitters.

The aerial gain, with null fill-in included, is typically 50, the main beam tilt being approximately 0.5° while the horizontal radiation pattern is circular to within less than 4dB. The v.s.w.r is less than 1·10 over the full frequency band and within 1·05 over the three channels eventually planned for any one site.



A u.h.f aerial. An example of the feeder system to each half of the aerial is shown on the left and the dipole arrangement on the right.

In addition to the normal performance checks the radiation patterns of the aerials have been measured by helicopter using the German Bundespost method. By this means twenty aerials all over Sweden were measured in one month.

As each station has been installed field strength and picture quality measurements have been made. This work was considered vital, both from the fault location aspect and to provide quickly the data needed to plan the transposer programme.

TRANSMITTER STANDBY SYSTEM

As stated, only single u.h.f transmitters have been installed to date. Some possible solutions for the standby systems are:

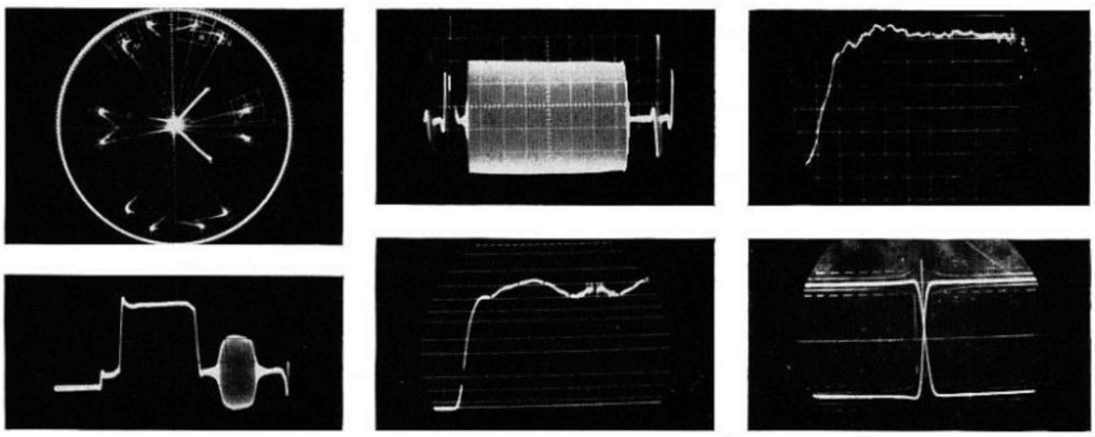
Type A. Parallel operation, active spare.
Type B. Standby operation, passive spare.
Type C. Multiplex operation.

Type A employs two identical transmitters, and Type B is also normally arranged this way. Type C means some reduced spare with, for example, three final amplifiers – two for vision and one for sound. In a spare operation condition one possibility is to use, for example, one amplifier for both sound and vision, but other combinations are equally possible. With Type C there is a reduction in the number of amplifiers of one or two compared with types A or B.

All existing Swedish v.h.f television and sound broadcasting transmitters are arranged for parallel operation. However, the weak point in this solution is that the complete system can only be tested outside of programme hours. This applies also to the multiplex solution. The standby system eliminates this restriction and also gives only two combinations to test. The weakness of the standby system is the interruption occurring when switching over to the spare transmitter. All of the Swedish u.h.f transmitters are arranged so that they may be used at half the nominal output power level. This means that either the Type A or Type B solution can be chosen. The intention is that, after experience of the reliability of the transmitters, one of these two alternatives will be selected. As the thoughts are at present the preference is for the simple standby system.

FUTURE PLANS

The second stage of the network contains plans to increase the coverage from the 95% of the 1 July 1971 to 99% by July 1978. During the second stage ten transmitter and some 160 transposer stations are expected to be installed, together with the standby transmitters.



A selection of transmitter test reports.