SRI LANKA STANDARD 771 : 1986

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CODE OF PRACTICE FOR RECEPTION OF TELEVISION BROADCASTING

SRI LANKA STANDARDS INSTITUTION

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Gr. 8

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FOREWORD

This Sri Lanka Code of Practice was authorised for adoption and publication by the Council of the Sri Lanka Standards Institution on 1986-12-17, after the draft, finalised by the Drafting Committee on Code of Practice for Reception of Television Broadcasting, had been approved by the Electrical Engineering Divisional Committee.

All values in this standard have been given in SI units.

The assistance derived from the publication of the British Standards Institution in preparation of this standard is gratefully acknowledged.

1 SCOPE

This code of practice covers recommendations regarding the provisions of antenna systems and cabled distribution systems for ensuring good reception of television broadcasts. This includes the protection of such systems against atmospheric electricity, danger from electric shock, fire and other hazards.

2 REFERENCES

IEC 728 - Cabled distribution systems primarily intended for sound and television signals between 30 MHz and 1 GHZ

SLS 640 - Safety requirements for mains operated electronic and related apparatus for household and similar general use

3 DEFINITIONS

For the purpose of this Code of Practice for following definitions shall apply.

3.1 antenna : A device comprising either a single element or an assembly of elements capable of converting the intercopted electromagnetic waves into an electromotive force at its terminals.

3.2 antenna element : A primary or secondary radiator which is a component of an antenna.

3.3 parasitic element : An antennae, lement not connected to a transmitter by a feeder.

3.4 lobe : That portion of the radiation pattern of an antenna which is contained within a region bounded by direction of minimum radiation.

3.5 main lobe : The lobe containing the direction of maximum radiation.

3.6 signal-to-noise ratio : The ratio of the power of the wanted signal to that of the co-existent noise, at a specified point and for specified conditions.

4 TELEVISION RECEPTION

4.1 Principles of television reception

The antenna at the transmitting station radiates a carrier wave into the surrounding space. The amplitude or the frequency of this wave is modulated by the audio and video signals which carry the sound and vision information, respectively. The waves are polarized either horizontally or vertically depending of the orientation of the transmitting antenna. The sound and vision information contained in the carrier wave is extracted from it by intercepting the carrier wave with a receiving antenna, which results in an electric signal being developed across the antenna terminals.

In the space where carrier wave is present, an electromagnetic field is created. The strength of the signal developed depends on the strength of this field and this decreases rapidly with increasing distance from the transmitting antenna. Television transmission cannot, generally, be rapidly propagated beyond the line of sight range and therefore the service areas are limited by the height of the transmitting antenna as well as by the power radiated. Several stations are therefore required to provide national coverage.

4.2 Services to be received

Television programmes in Sri Lanka are transmitted presently on CCIR* system B in VHF band III and PAL** colour system. Provision has also been made to transmitt on CCIR system G in UHF bands IV and V. Details of the standards of these systems are given in Appendix A.

* *CCIR - Consultative Committee International Radio*
** *PAL - Phase Alternation Line*

4.3 Choice of a receiver

TV receivers intended for use in Sri Lanka shall be designed to receive transmissions on CCIR system B, PAL colour system (see Appendix A). They shall have frequency coverage in VHF band III (channel 5 to 12), and in addition may cover UHF bands IV (channel 21 to 37) V (channel 38 to 68) on CCIR system G. The receivers may be operated on either 230 V, 50 HZ mains supply or d.c. supply.

The receivers shall conform to the requirements laid down in SLS 640, in respect of safety.

4.4 Basic requirements for good reception

A clear line-of-sight path between the transmitting and receiving antennae is the basic requirement for good reception, of TV signals. Therefore, a transmitting antenna erected on a mountain peak can provide a wider coverage than one on a lower level. For example, the transmissions from Mt. Pidurutalagala which is at a height of 2400 m, extends to over 215 km while those from Kokavil which is less than 100 m above sea-level, do not extend to more than 63 km, when a receiving antenna of height 10 m is used.

The primary service area where good quality reception could be assured is determined by the strength of the field at a height of 10m, above ground level. Where the background noise level is low, this quantity is taken as 55 dB (µV), or 0.56 mV. However even outside the primary service area, good quality reception could be obtained by erecting antenna at heigher elevations or employing high gain antennae.

A receiving antenna of adequate gain has to be employed to convert the radiation field into a voltage level above a minimum specified value at the receiving antenna terminals. Too high a gain could cause distortion and breaking into adjacent weak channels causing interference. The recommended minimum and maximum voltage levels at the receiver input terminals of impedance 75 ohms, for good reception in the VHF band is given in Table 1.

TABLE 1 - Recommended Minimum and Maximum Voltage levels in the VHF band

Quality	Maximum Signal level	Minimum Signal level
Voltage level across terminals of 75 ohm	2.5 mV	0.5 mV
Field strength when using an antenna of gain 10 dB and cable of 1.5 dB loss	1.8 mV/m or 65.2 dB (µV/m)	0.37 mV/m or 51.2 dB (µV/m)

The quality of the picture is also governed by the presence of noise at the receiver terminals. For good quality pictures the carrier signal-to-noise power (C/N) ratio has to be high. Table 2 gives the C/N values corresponding to different grades of picture quality when operated in the VHF band III.

TABLE 2 - C/N values for different grades of picture quality

Grade picture quality	Evaluation of picture	C/N ratio (dB)
5 Excellent	No disturbance is observed	More than 48 dB
4 Good	Disturbance is present but unnoticed	More than 37 dB
3 Fair	Disturbance is noted but not troublesome	More than 29 dB
2 Poor	Disturbance is obvious and troublesome	More than 22 dB
1 Unusable	Reception is not achievable due to excessive disturbance	Less than 22 dB

Even with a clear path between the transmitter and receiver, it is sometimes found that the picture quality is degraded dut to the appearance of multiple images, referred to as 'ghosts'. It often happens that the signal arrives at the receiving antenna not only by the direct path from the transmitting station, but also after reflection from one or more objects such as hills or tall buildings. Rrflected signals arriving later can produce multiple images on the screen.

An antenna with good directional properties may be used to minimize multiple images and also to discriminate against unwanted signals from other transmitting stations using the same channel as, or adjacent channels to, those used by the wanted station. The selection of a proper location is also important in eliminating undesirable interfering signals.

4.5 Site investigation

The position of the antenna is of considerable importance. All local obstructions between receiving antenna and the transmitter should be avoided as far as possible. Multiple images may often be eliminated by a careful choice of position for the antenna and by proper use of its directional properties. To study the effect of reflections, it is necessary to use equipment that will either give a picture display or provide the possibility of observing delayed secondary signals. It must be noted that the attenuation effect of trees on television signals is significant and therefore should be avoided.

Where practicable, antenna should be mounted well clear of other conductors, including structural metal work and other antennae. Every effort should be made to install antennae as far as possible from power lines, to avoid danger from electricution.

5 TELEVISION ANTENNA

5.1 Antenna fundamentals

The half-wave folded dipole forms the basis of most TV antennae. This is a modification of the simple dipole which consists of two conductors, each about 5% shorter than a quarter wave length placed end-to-end separated by a gap of about 1 cm. The far ends of the simple dipole are connected together by a second length of conductor placed parallel to the simple dipole with a spacing of about 5-6 cm. The ends of the conductors across the 1 cm gap form the antenna terminals.

An important characteristic of an antenna is its impedance. While a simple dipole has a nominal impedance of 75 ohms, the folded dipole impedance is 300 ohm nominally. For optimum transfer of power from the antenna to the receiver via the antenna cable, the impedances should match at the antenna to cable and cable to receiver connections. If there is any mismatch a suitable matching transformers should be employed.

The mismatching of the antenna impedance to that of the cable and the receiver is the cause of poor reception in most cases.

The dipole antenna has its maximum sensitivity in a direction at right angle to the antenna, and receive signals coming from both directions. In order to restrict the sensitivity only to one direction, the dipole is incorporated in an array with a number of additional elements, one of which functions as a reflector and others as directors.

The reflector, which is slightly longer than the dipole is placed behind this dipole while the directors are all placed in front of the dipole, as shown in Fig.1. Since these additional elements are not electrically connected to the dipole, they function as parasitic elements. Antenna arrays of this nature are called Yagi Antennae. The complete array is designated by the number of elements, counting the dipole, whether simple or folded, as one. Thus, an array of a folded dipole with a reflector and three directors is a five-element antenna. Sometimes, the reflector, instead of being a single conductor, may consist of several conductors placed in a plane normal to the array, but it is counted as one element.

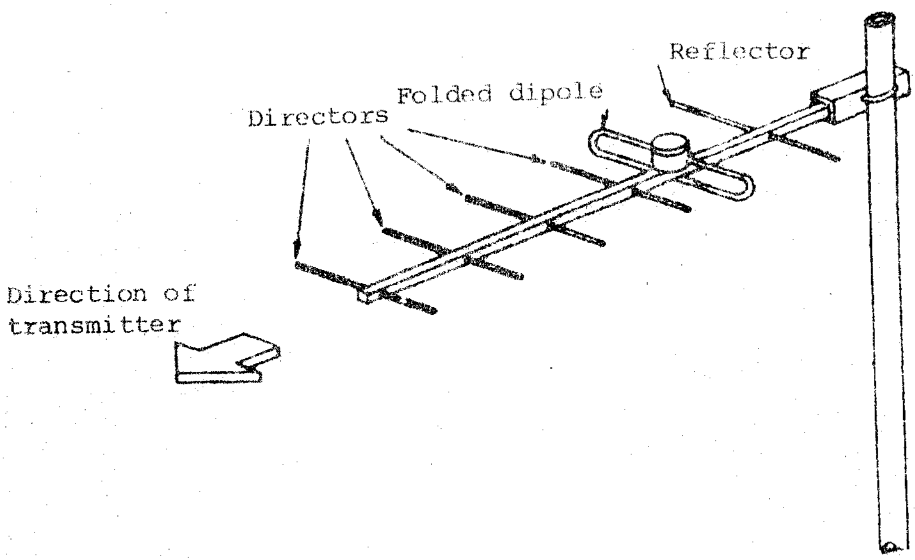

FIGURE 1 - Yagi Antenna

When the two transmitters are in the same general direction, but one is very weak and the other strong, a high gain antenna with or without further amplification has to be used to pick up the weak signal. However, in such instance, to avoide the overloading of the receiver by the strong signal and its breaking into the weak channel a suitable trap or a filter has to be inserted in the feeder cable. This filter may be incorporated into the amplifier itself so that it will amplify only the weaker signal.

In areas where the field strength is weak it is essential that high gain antennae are used. In some instances these also may not provide a clear picture and further amplification of the signal may be necessary. Consideration also should be given to the fact whether both transmitters are in the same general direction or otherwise. Particular care should also be taken to ensure that the antenna band-width is wide enough to cover both channels.

If the transmitters are approximately in the same direction, one high gain antenna with or without further amplification may serve. Otherwise it may be necessary to install two separate antennae for the two transmissions. In such instance, each antenna could be adjusted to provide maximum sensitivity for each channel. The feeder cables from the two antennae could be connected to the receiver through an antenna coupler.

It is sometimes observed that in areas where the signal coming from the direction of the transmitter is weak, that a secondary signal comes stronger from a different direction after getting reflected from a nearby hill or a tall structure. This is particularly so when the direct path is beyond the line of sight or obstructed. Therefore in such places, the antenna should be first scanned to determine the direction of optimum reception before the antenna is secured finally.

5.3 Antenna down-lead

The energy picked up by the antenna is transferred to the receiver using a suitable cable. Broadly two types of cables are used for this purpose. One is co-axial cable having a characteristic impedance of 75 ohm and the other a flat twin type of characteristic impedance of 300 ohm. The impedance of the cable should match that of the antenna terminals as well as that of the receiver input. When this cannot be achieved directly, suitable matching transformer has to be used.

Generally, black and white receivers have 300 ohm input terminals, while colour receivers have 75 ohm terminals. The choice of the cable should therefore depend on the receiver type and any mismatching at the antenna terminal is corrected by connecting the cable through a matching transformer.

A transformer at the antenna terminal is required for another reason, particularly when connecting co-axial cable to the antenna. A folded antenna has symmetry while a co-axial cable is an asymmetrical un-balanced system. For optimum transfer of energy from a balanced system to an un-balanced system, a balance-to-unbalance transformer, known as a balun has to be used. It is possible to incorporate both the impedance conversion and the balance-to unbalance conversion in one transformer. If a co-axial cable is connected directly to a dipole terminals, the signal picked up by the antenna is transferred to the receiver along with any noise picked by the system also, thus degrading the signal-to-noise factor.

In selecting a cable, two other factors have to be taken into consideration. One is the loss of the signal along the cable referred to as the cable loss and the other, their ability to pick up noise. Though the co-axial cables have high loss they are better in shielding the signals from external noise. The twin flat cables are susceptible to external noise, hence should not be used with week signals. However, their loss properties are better compaired to those of co-axial cables. Table 3 gives some typical values of cable losses at VHF Band III frequencies in respect of more common types of cables used.

TABLE 3 - Impedances and the losses for different types of cables

Cable type	Impedance (ohms)	Loss (dB/10m)
Co-axial	75	1.1 - 1.8
Twin flat	300	0.9

In low signal areas even with receivers having 300 ohm input terminals, it is preferred to use a co-axial cable connected to a high gain 75 ohm to 300 ohm matching transformer.

6 INSTALLATION OF ANTENNA

6.1 Material

In order to ensure satisfactory performance and durability of an out door antenna system due regard should be paid to protection against any possible deterioration of components as a result of continued exposure to climatic variations. The materials selected for the antenna installation should be chosen so as to resist corrosion.

Generally, the antenna array is constructed of aluminium tubing and this has natural protection against corrosion. All other components, including masts and mounting brackets should be made of steel. These parts should be protected by hot-dip galvanizing or by zinc or cadmium plating. If dissimilar metals are brought into contact they should be selected or plated so as to minimize galvanica corrosion.

6.2 Antenna mast

Generally galvanized steel tubular masts are used to mount antenna arrays. In selecting the size of mast, consideration should be given to the required, height and the loading due to the antenna and wind. The masts should have minimum wall thickness and maximum length for a given diameter.

Where the antenna height is not excessive and the mast is of metal it may be installed on the ground itself which would eliminate need for separate earthing.

When it is necessary to mount the mast at a height above the ground it may be secured using a minimum of 2 brackets. Antenna masts of more than 6 m should be supported with a minimum of 3 guy wires positioned equi-angularly and properly anchored to the ground or other suitable points.

For every 6 m length of antenna mast there should be a set of guy wires each set comprising a minimum of three.

7 CABLE DISTRIBUTION SYSTEMS

7.1 General

Cabled distribution systems provide a means of distributing television programmes over a network to receivers that may be, for example, within a group of individual dwellings, within a block of flats, in rooms in a hotel, or spread throughtout a town. The cabled systems will comprise any necessary equipment to process, amplify and distribute the incoming signals.

7.2 Distribution of television programmes in the VHF Bands

A typical system will use co-axial cable and include some, but not necessarily all of the following :

(a) an antenna system ;

(b) low-noise antenna amplifiers ;

(c) amplifiers ;

(d) equalizers ;

(e) trunk, branch, spur and subscriber feeders ;

(f) splitters and subscriber tap-off units ; and

(g) system outlet units.

7.3 Received signals

The signals to be used on a cabled distribution system, their reception and distribution frequencies should be clearly specified. Wherever practicable, signals from main transmitters should be used in preference to those from relay transmitters which, inevitably, will be somewhat less reliable.

In areas of difficult reception or when reception from a distant transmitter is being considered, account should be taken of the possible effects of short term and long-term fading and/or interference, including that possible from any planned transmitter(s).

7.4 Head-end precautions

Antenna should be erected at as early a stage as possible and tests carried out to establish the levels and quality of the available signals, taking into account as far as possible future buildings that may be planned for the locality. It may be necessary to find the best position after the building has been completed.

Unforeseen impairments in the quality or level of the signal may be found, due to unfavourable reception conditions or propagation which appear, for example, as multiple images (echoes), patterning, bars or as noise. In these cases early consideration should be given to remedial action, such as resiting the antenna and/or using antenna of higher gain and directivity.

For good quality the input signal, in dB(mV), at the head end should be not less than (F_{eff} - 8).

where,

F_{eff} is the effective noise figure of the head-end equipment in dB (mV).

NOTE - If necessary, antenna having a higher gain should be used to obtain these input levels.

Where, despite the use of higher-gain antenna, the recommended input levels cannot be achieved because of low field strengths or the gain of the head-end amplifier is inadequate, a low-noise pre-amplifier should be fitted at the antenna end of the feeder.

If such a low-noise pre-amplifier is fitted, it should, where possible, be located at or adjacent to the head-end equipment, taking into account stability in order to facilitate maintenance and test. Where the attenuation of the signal in the cable between the antenna and the head-end is significant even with the use of very low loss cable, it may be necessary to locate the pre-amplifier remote from the head-end. In this case it is recommended that it should be provided with its own independent power feed and hence be connected so that its output is immediately accessible for test, otherwise disconnection of the antenna feeder will render the amplifier inoperative.

7.5 Distribution frequencies

On co-axial systems it is usual to distribute programmes at the same frequencies as those used for reception. If, however, the system operates within an area of high transmitter signal strength, interference may be experienced by system viewers due to pick-up of this signal on the network and on receivers. Similarly in an area of poor signal strength any radiation from the network may cause interference to nearby direct reception viewers.

Under these conditions it may be desirable or necessary to translate signals from their reception frequencies to different distribution frequencies, in order to overcome these difficulties or to avoid mutual interference between receivers.

7.6 Co-axial distribution systems

7.6.1 *Equipment*

In order to utilise the maximum capability of active equipment, it is important that at their outputs all signals are at the planned operating levels and equipment should be provided with means to monitor and adjust the levels. A wide-band amplifier can be used at the head end if the output signal levels in each band can be maintained to within 3 dB of each other and the performance requirements of IEC 728 are satisfied.

7.6.2 *Installation of equipment*

Amplifying equipment should be arranged for easy replacement and housed in robust, lockable enclosures to prevent danger to an interference by persons. It should be located for convenient access at all times and at a convenient height for adjustment of the controls. Where equipment has to be installed on exterior or interior walls, it should be mounted at a height that will minimize unauthorised access.

Enclosures should provide adequate ventilation and those for outdoor installation should be proof against driving rain be provided with appropriate cable glands.

7.6.3 *Reflections*

Equipment used in systems built in accordance with this code will have a nominal impedance of 75 ohm.

In general, the equipment should have a standing wave ratio (s.w.r.) specification not exceeding 1.5 : 1 in the working band.

7.7 Installation of distribution cabling

7.7.1 *General*

Cables should always be unwound directly off drums and handled so as to avoid any possibility of being pulled into a kind or bent to any extent. When installed, the radius of cable bends should always be as large as practicable and in any event not less than the minimum specified for the cable.

A single unbroken length of cable should be used between items of system equipment. Where a joint is unavoidable, a purpose designed connector providing a good electrical match should be used and installed above ground in a weather proof inspection chamber.

7.7.2 *Cabling in ducts*

Underground ducts should be laid to a minimum depth of 450 mm (600 mm beneath roads) from the finished ground level to the upper surface of the duct at the time of installation.

Where a cable passes beneath a road, a hard-standing area, etc., it should be enclosed in a duct of 90 mm minimum internal diameter, terminated at each end by an inspection chamber of internal dimensions not less than 300 mm x 400 mm depth, except where otherwise specified at intervals along a long cable route to avoid exceeding the maximum pulling force.

7.7.3 *Overhead cabling*

Minimum separation of 600 mm should be maintained from any Telecommunication line.

Overhead cable spans should be supported by messenger wires.

8 EARTHING AND PRECAUTIONS AGAINST DAMAGE AND INTERFERENCE FROM ATMOSPHERIC ELECTRICITY

When television receivers have their chassis directly connected to the mains supply, such chassis should in no circumstances be earthed.

Metal masts, supporting structures and the booms of television antenna should be connected to the earth to minimize the buld up on antenna installations of static charges that cause damage, danger, and interference. In most cases, it is sufficient to ensure that the mast is earthed, relying on the clamp that secures the antenna to the mast for electrical contact between the antenna and the mast.

The antenna system should be connected to any earthed metal work situated near the top of the structure, for example water tanks or pipes, using an earthing clamp. If no earthed metalwork is available, the earth connection should be made by the most direct route to the nearest earthing point. A copper conductor should be used for this connection with a minimum cross-sectional area of 1.5 mm^2.

In some antenna designs the elements are not in electrical contact with the boom to which they are secured and no such connection should be made.

With some antenna the outer conductor of the antenna feeder is not connected to the supporting metalwork of the antenna. In this case, the outer conductor should be separately earthed at the receiver end of the downlead.

APPENDIX A

CHARACTERISTIC OF CCIR SYSTEM B/G TV TRANSMISSION, AND TRANSMITTING STATIONS AND THE FREQUENCY OF TRANSMISSION

TABLE 4 - Characteristics of CCIR system B/G TV transmission

ITEM	CHARACTERISTICS	B/G SYSTEM TELEVISION
1	Number of lines per picture (frame)	625
2	Field frequency, nominal value (field/second)	50
3	Line frequency f_H and tolerance when operated nonsynchronously (Hz)	15625 $\pm$ 0,02%
4	Nominal video band width (MHz)	5
5	Nominal radio-frequency bandwidth (MHz)	B(7) G(8)
6	Sound carrier relative to vision carrier (MHz)	5.5 $\pm$ 0.001
7	Nearest edge of channel relative to vision carrier (MHz)	-1.25
8	Nominal width of main side band (MHz)	5
9	Nominal width of vestigial side band (MHz)	0.75
10	Type of polarity of vision modulation	C3F Neg
11	Type of sound modulation	F3E
12	Frequency deviation (kHz)	$\pm$ 50
13	Pre-emphasis for modulation (µs)	50

TV programmes are telecast by the Sri Lanka Rupavahini Corporation (SLRC) and the Independent Television Network (ITN) in Band III (VHF). The channels assigned to each of these services and the details of their transmissions are given in Table 5.

TABLE 5 - Transmitting Stations and Frequency of Transmission

Transmitter location	Services	Channel No.	Frequency Allocation (MHz)	Vision carrier (MHz)	Sound carrier	Effective radiated power
Mt. Pidurutalagala	Rupavahini	5	174 - 181	175.25	180.75	200 kW
Kokavil	Rupavahini	8	195 - 202	196.25	201.75	200 kW
Kandy	Rupavahini	10	209 - 216	210.25	215.75	60 kW
Namunukula	Rupavahini	10	209 - 216	210.25	215.75	10 kW
Sooriya Kanda	Rupavahini	11	216 - 223	217.25	222.75	1040 W
Kotte	ITN	12	223 - 230	224.25	229.75	95 W

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The principal objects of the Institution as set out in the Act are to prepare standards and promote their adoption, to provide facilities for examination and testing of products, to operate a Certification Marks Scheme, to certify the quality of products meant for local consumption or exports and to promote standardization and quality control by educational, consultancy and research activity.

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All members of the Technical and Sectoral Committees render their services in an honorary capacity. In this process the Institution endeavours to ensure adequate representation of all view points.

In the International field the Institution represents Sri Lanka in the International Organization for Standardization (ISO), and participates in such fields of standardization as are of special interest to Sri Lanka.

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