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*Translation*

# ORI

## Technical regulations for international analogue ground-train radio systems

*Prescriptions techniques pour les systèmes analogues radio sol-train en service international*  
*Technische Vorschriften für Analog-Zugfunksysteme im internationalen Dienst*



UNION INTERNATIONALE DES CHEMINS DE FER  
INTERNATIONALER EISENBAHNVERBAND  
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For digital ground to train systems: see UIC Leaflet 751-4.

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*The person responsible for this leaflet is named in the UIC Code*

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## Summary

This leaflet contains technical regulations for ground-train radio systems in international traffic.

It defines the scope of the leaflet, describes operating modes plus minimal technical specifications.

Detailed provisions ensuring quality of communications are also given, with emphasis on: location of fixed installations, radio coverage, technical transmission/reception characteristics, fixed and mobile aerials, operating modes, quadri-frequency sets, auto-switching of mobile-set frequencies, cable links, loudspeakers and tractive-unit micro-telephone sets.

The leaflet then defines the frequency chart: setting-up and allocation of channels, joint frequency bands, distance between channels, duplex channels, numbering of channels, intermodulation, preferential channels, switchable channels and simplex channels aboard tractive units.

The different radio-control processes are also described: idle mode, connections, operating provisions and warning procedures.

The corresponding command signals are explained in detail.

Links between motive power unit and RIC coaches together with the corresponding communications between drivers, central control and train staff are explained in specific terms.

Finally, the leaflet describes the special features of the ground-to-train radio system with selective call and message transmission by digital code, as well as those of the radio-telephony system with simultaneous transmission of digital messages.

# 1 - General

## o 1.1 - Scope of leaflet

The railways utilise radio links with numerous different modes of operation.

Operations in frontier zones must comply with the provisions of *UIC Leaflet 471-1* (see Bibliography - page 57).

**1.1.1** - This leaflet only concerns installations and equipment for providing permanent analogue radio links between traffic control points and trains running on lines used for international traffic with tractive units crossing frontiers.

For those railways which utilise other systems than radio, bilateral agreements can be concluded between adjacent railways.

**1.1.2** - The leaflet does not apply to radio systems:

**1.1.2.1** - established along lines where no international traffic runs, and fitted to tractive units which do not leave their own network;

**1.1.2.2** - established along frontier lines and on tractive units which run over them without penetrating far onto a foreign network;

**1.1.2.3** - established on trains to enable passengers to connect up with the public telecommunications network (service to passengers);

**1.1.2.4** - using the resources of public telecommunications networks.

**1.1.3** - The leaflet applies to links between the radio installation of tractive units and the loudspeaker equipment of passenger trains (see *UIC Leaflet 568*) (see Bibliography - page 57), enabling announcements to be made to passengers or to train staff.

**1.1.4** - In addition, the leaflet applies to links with sound installations in one or more passenger coaches for duty communications concerning train staff.

**1.1.5** - The GSM-R system is covered by a separate new leaflet.

The present leaflet contains technical regulations for communications between driver and train staff or between central control and train staff, established through the radio equipment of the tractive unit via the link circuit passing along the train and the various service points installed in the coaches and vans.

## o 1.2 - Modes of operation

**1.2.1** - Compatibility between mobile and lineside radio equipment of different Railways.

Radio links with the trains can be utilised in different ways.

However, for practical reasons, the equipment of tractive units crossing frontiers may not be developed for all imaginable and possible modes of utilisation.

Thus, only two different modes of utilisation have been defined, in conformity with the directives of the UIC Operating Committee (see Bibliography - page 57):

- mode 1, with confidentiality of conversation, one of the features of which is that it functions in duplex and will therefore be described as "duplex mode";
- mode 2, without confidentiality of conversation, one of the features of which is that it functions in semi-duplex, and will therefore be described as "semi-duplex mode".

Each Railway may choose the mode of utilisation it intends to adopt by reference to the advantages anticipated in relation to the investments to be undertaken.

Equipment fitted to tractive units worked over inter-running sections must be able to adjust to the duplex mode of operation once one of the Railways concerned in such traffic starts to utilise this mode.

When the semi-duplex mode of operation is used over inter-running sections, bilateral or multilateral agreements govern the conditions under which the tractive units must adjust to the semi-duplex mode of operation.

The provisions for the setting up of lineside installations must be adapted to ensure compatibility with the standard equipment of tractive units.

#### **1.2.2 - The "duplex mode" must allow for:**

**1.2.2.1** - direct verbal communications between lineside control point (central control) and driver. Calls can be made to trains verbally or selectively (by digital code). Communication must proceed in conditions ensuring confidentiality of conversation.

**1.2.2.2** - communications between driver and operating supervisory along the route: these are established through intervention from the central control. The call can also be verbal or selective, and the communication established must observe confidentiality of conversation.

**1.2.2.3** - alarm-signal transmission by the driver in order to establish urgent verbal communication with central control or warn other drivers of danger.

**1.2.2.4** - message transmission by central control to all drivers (general call) to warn them of danger or for other service information.

**1.2.2.5** - permanent supervision of the reception of lineside stations and indication if it is defective, on the tractive units.

**1.2.2.6** - message transmission by central control or driver, via the loudspeakers in the coaches, to inform train staff or passengers.

**1.2.2.7** - verbal communications between driver and train staff in trains or between central control and train staff.

**1.2.2.8** - a radio link independent of the position of the train throughout the zone managed by central control.

Verbal radio communications must not be disrupted by changes in the coverage zone of lineside stations. Central control must not be made responsible for activating a selective system to interlock lineside stations relative to the position of the trains.

### **1.2.3 - The "semi-duplex mode" must allow for:**

**1.2.3.1** - open verbal communications between driver and central control without confidentiality, and with verbal calling (for example, through connection of one or more lineside stations to a link circuit with central control).

All users within the zone covered by the connected lineside installations hear the calls and conversations.

**1.2.3.2** - direct verbal communications between driver and operating staff of the lines, with verbal calling.

All users within the zone covered by a radio transmitter (lineside points and drivers) hear the calls and conversations inside this zone.

**1.2.3.3** - direct verbal communications between drivers situated in the zone covered by the same lineside station, with verbal calling without confidentiality, the lineside stations serving as relays.

All users within the zone covered by a lineside station will hear the calls and conversations inside this zone.

**1.2.3.4** - alarm-signal transmission by a driver, either to warn the other drivers running over the line of danger, or to establish urgent communication with central control via the lineside points established along the line.

**1.2.3.5** - message transmission by central control to all drivers (general call).

**1.2.3.6** - permanent monitoring of the reception of lineside stations and indication of a defect, on the tractive units.

**1.2.3.7** - message transmission via the loudspeaker in passenger coaches as in point **1.2.2.6** - page 3.

**1.2.3.8** - verbal communications between driver and train staff or between central control and train staff as in point **1.2.2.7** - page 3.

## **1.3 - Minimal technical regulations**

**1.3.1** - The minimum technical regulations must guarantee operational compatibility between the radio equipment of tractive units crossing frontiers with the radio equipment of the lines of other Railways.

The following paragraphs define these minimum technical regulations, to guarantee:

- transmission of sound communications of good quality and, where applicable, transmission of digital codes under satisfactory conditions;
- standardisation of radio frequencies used;
- standardisation of tones used as operating signals to regulate the progress of communications and the priority of warning information;

- the possibility for Railways wishing to do so, of making joint use of a selective and data transmission call system in digital code.

**R 1.3.2** - When the radio apparatus of a Railway is not equipped initially for the transmission of digital codes, it is recommended that provision be made for its subsequent development whereby it can be supplemented later by adding an additional housing for this function.

## 2 - Regulations guaranteeing quality of communications

### R 2.1 - Lineside stations

Radio links with trains are established from lineside stations installed along railway lines. They must be close enough together for a satisfactory quality of communications to be obtained down length of the line.

Satisfactory coverage of an entire line with radio waves means that the reception voltage, at the input end of receivers of the tractive units and the lineside stations, must attain or exceed the minimum value prescribed in point 2.4 over 95% of the route and for 95% of the time.

### o 2.2 - Sensitivity of lineside and mobile receivers

With a reception voltage of  $\geq 1 \mu\text{V}$  at the input end of receivers, the signal/noise ratio level at their output end must be  $\geq 20 \text{ dB}$ .

When measuring this characteristic the noise arrester must be made inoperative. The workable signal consists of an oscillation at 1000 Hz with a frequency deviation of 3,0 kHz. Noise is measured by injecting a non-modulated HF signal. The levels of the workable signal and of the noise are measured in actual values.

### o 2.3 - Coefficient of distortion in transmitters and receivers

The non-linear coefficient of distortion of a transmitter or receiver, measured by applying a signal of 1 mV to the nominal frequency (frequency of the radio channel) modulated by a frequency of 1000 Hz, must be:

$\leq 7\%$  with a frequency deviation of 3,5 kHz,

$\leq 10\%$  with a frequency deviation of 4,0 kHz.

### 2.4 - Minimum reception voltage

Satisfactory transmission of the spoken word means that the vocal frequency signal captured by the receiver in the 300-3000 Hz band must be at least 20 dB above the interference signals.

**2.4.1** - Given the interference which exists in the VHF band, within the railway environment, and bearing in mind also the reduction in frequency deviation (see point 2.9.3 - page 8), this requirement is achieved when a minimum reception voltage of  $2 \mu\text{V}$  exists at the input end of receivers of the tractive units.

It is also assumed that an  $\lambda/4$  omnidirectional aerial with a characteristic impedance of 50 ohms is installed on the roof of tractive units (namely about 4 m above rail level).

**2.4.2** - Because the properties of reciprocity of the links in both directions and in the light of experience gained with systems already in operation, it has been established that the quality of transmission from tractive units to lineside stations is just as good and even better than from lineside stations to tractive units. Accordingly, the lineside transmitters and those on the tractive units are

assumed to have the same power. (The directional effect of the lineside aerals does not enter into this consideration since it operates in both directions).

Thus, the minimum reception signal at the input end of the lineside receivers should be  $2 \mu\text{V}$ , for a typical impedance of 50 ohms.

## 2.5 - Radiating power

- 2.5.1 - The nominal radiating power of the equipment on tractive units must be 6 watts.

In several countries, higher ratings are prohibited, while lower ratings would reduce the ranges and would require installing a larger number of lineside stations.

- R 2.5.2 - The radiating power of lineside stations should also be 6 watts (see point 2.4.2 - page 6).

## ○ 2.6 - Polarisation of radio waves

In the open air, vertical polarisation must be adopted.

In tunnels, any polarisation can be used (see point 2.8).

## ○ 2.7 - Aerials of tractive units

2.7.1 - In the open air, the aerials for tractive units must have omnidirectional radiation characteristics and show a gain of 0 dB or more in relation to an  $\lambda/4$  aerial.

They must be fitted on the locomotive roof to obtain a vertical polarisation, and to avoid, as far as possible, reflections and refraction due to the roof superstructure. The loss of gain can attain 9 dB with unsatisfactory fitting conditions.

2.7.2 - To protect staff against dangerous over-voltages in the event of accidental contact with parts under high voltage or with the contact wire, aerials must be connected by galvanising to the frame of the tractive units (in other words brought to the potential of the rail).

They can also be protected by an insulating screening of synthetic material.

2.7.3 - Aerials must be installed to comply with the rolling-stock gauge.

## R 2.8 - Aerials of lineside stations

In the open air, all types of aerial with vertical polarisation can be used. The best characteristics to be adopted for the aerials (for example, omnidirectional, slightly or very directional) depend on the topography of the zone to be served.

Radio coverage in tunnels can be obtained by means of radiating circuits (for example, coaxial cables with split screening) or very directive aerials placed at the entrance to or inside the tunnel. In addition, so-called coiled aerials, very directional and with circular polarisation, have proved very favourable in terms of obtaining considerable ranges in tunnels.

## o 2.9 - Type of modulation. Frequency deviation

**2.9.1** - For radio transmission, frequency modulation (16 F3 type of modulation) should be adopted.

**2.9.2** - With a margin of 25 kHz between radio channels, the maximum frequency deviation is 5 kHz.

However, since the coefficient of distortion mentioned in point **2.3 - page 6** is only low enough below 4 kHz, the maximum frequency deviation for simultaneous transmission of the spoken word and of an operating tone is fixed at the nominal value of 4 kHz.

**2.9.3** - This maximum frequency deviation should be divided as follows:

- For an operating tone (see point **5 - page 19**) : 1,75 kHz in nominal value
- For the spoken word : 2,25 kHz in nominal value

**2.9.4** - For each transmission direction of the radio channel, it is prescribed that:

- the peak values of the signal corresponding to a normal sound level shall be transmitted, in accordance with point **2.9.3**, subject to a frequency deviation of 2,25 kHz (nominal value),
- the average values of the signal corresponding to this normal sound level shall be transmitted subject to an average value of 1,1 kHz of the frequency deviation.
- the signals corresponding to very high sound levels must be concentrated before modulation in the transmitters, to limit the frequency deviation to the peak value of about 2,25 kHz.

## o 2.10 - Duplex and semi-duplex operation

**2.10.1** - Compliant with point **1.2.1 - page 2**, mode 1 utilisation involves duplex operation. This mode of operation is usual on public radiotelephony networks, and in applications specific to railway operation. It facilitates conversation in service radio communications.

It does not require any switching or timing device for digital-code information bilateral exchanges, and therefore facilitates message transmission.

**2.10.2** - For mode 2 utilisation, the semi-duplex system of operation should be adopted (alternate transmission and reception, utilising two different frequencies) in accordance with the provisions described in point **1.2.3 - page 4**.

**2.10.3** - The radio equipment of tractive units must be able to function in accordance with the directives given in point **1.2.1**.

## R 2.11 - Radio-wave coverage of line

The requirement of permanent monitoring of the radio link in accordance with points **1.2.2.5 - page 3** and **1.2.2.6 - page 3** implies continuous transmission of a carrier frequency by the lineside stations.

Transmission from each lineside station is a workable signal in the zone of coverage which it is required to serve, but becomes an interference signal in the zones outside. The distances, for which this interference can occur, depend on the topography of the terrain. They vary between 2 and 5 times the extent of the workable range, and in extreme cases can even be still greater.

To avoid interference which can be produced by two adjacent lineside transmitters interfering with mobile receivers, various arrangements can be adopted.

**2.11.1** - When the zones to be served are extensive and comprise at least three lineside stations, it is generally necessary to utilise alternately three transmission frequencies along the line. Generally speaking, the workable ranges of the lineside transmitters with the same frequency are then outside the zones where they interfere with each other.

**2.11.2** - In cases where the workable ranges of lineside transmitters with the same frequency nevertheless coincide with zones of interference without the level of the interference signal in the workable range of a transmitter exceeding a certain value ( $2 \mu\text{V}$  for the average reception voltage,  $5 \mu\text{V}$  peak value), the interference can be reduced satisfactorily by stabilising the two transmission frequencies so that they deviate by a maximum of  $\pm 25 \text{ Hz}$  from the nominal frequency, and by equalising the frequency deviations.

**2.11.3** - When the interference between transmitters in a zone of coverage corresponds to values exceeding those mentioned in **2.11.2**, stabilisation of frequencies is no longer sufficient. It is then necessary to increase the distance between these transmitters. This situation can be achieved by making the transmissions from two or three adjacent intermediate transmitters identical. This consists of:

1. stabilising the transmission frequencies of the transmitters so that they differ by no more than 50 Hz (recommendation for adjustment:  $\pm 5 \text{ Hz}$ ),
2. equalising their frequency deviations,
3. equalising the phases of the modulation signals in the zones of coverage of adjacent transmitters. This means equalising the propagation times of the modulation signals to the two transmitters and the propagation times of the radio signals along the line.

**2.11.4** - When the zones to be served are short and have no more than 3 to 5 lineside stations, it is possible to utilise the system with synchronised transmissions. A duplex channel is then sufficient to serve the entire line (see point **2.11.3**).

## o **2.12 - Quadrifrequency groups**

**2.12.1** - To serve a line in the general case defined in point **2.11.1**, it is necessary to have three frequencies for the lineside transmitters and a fourth frequency for the mobile transmitters. The switching of the reception frequencies in the mobile receivers must be carried out by means of an automatic device. To arrange this using the simplest possible technique, the four frequencies have been combined in a standard chart to form a "quadrifrequency group".

A duplex channel with a margin of 10 MHz between transmission and reception frequencies constitutes its nucleus. Two additional frequencies for the lineside transmitters are situated with a double channel margin (50 kHz), one above and the other below the transmission frequency of the lineside transmitters of the duplex channel.

**2.12.2** - To serve, independently of each other, certain lines whose alignments are close together, particularly near communications centres, several of these quadrifrequency groups are used. The manner in which they must be arranged will be addressed in point **3 - page 11** (Frequency chart).

## 2.13 - Automatic frequency switching of mobile receivers

- O **2.13.1** - On entering the radio service zone of a central control, drivers must connect to the corresponding channel (namely the one identified by the number of the quadrifrequency group). Within the range of the service zone, an automatic device must ensure switching of the reception frequencies belonging to this quadrifrequency group.

However, it must be borne in mind that switching operations when too frequent and also too late, create undesirable interference particularly during message transmissions envisaged for the future.

- R **2.13.2** - Switching can take place, for example:

1. either when the signal/noise ratio becomes continually or frequently insufficient in the receiver. This corresponds to the following data: when the reception voltage falls during a continuous period of about 1 s or several times during periods of 1 ms below the minimum of 2  $\mu$ V (see point 2.4 - page 6).
2. or when reception is better on another frequency than the one in use (namely when the signal/noise ratio is best), which must be detected by a comparator device.

One or other of these criteria can be utilised to effect the switching operation.

## R **2.14 - Sound-link circuit between central control and lineside stations**

Lineside stations must be connected to central control by two pairs of wires, one for the transmission direction and the other for the reception direction.

To ensure that the quality of transmission is as good as for the path of the radio waves, the circuits used should have characteristics which satisfy ITU standards for the 300 to 3400 Hz filter band (loaded or non-loaded circuits).

With these characteristics, the input amplifiers in lineside stations can still suitably compensate for variable attenuation in relation to the frequencies, even for the control signal with the highest frequency (2800 Hz, see point 5.4 - page 20).

## O **2.15 - Calls via loudspeakers. Conversations using the micro telephonic handset**

The ambient noise level is generally high on tractive units, and interferes with the comprehension of loudspeaker announcements. Use of the micro-telephonic handset improves comprehension of the spoken word in both directions. On the one hand, the ambient noise is muted by the telephone receiver, and on the other the microphone is maintained at a certain distance, which guarantees a constant level for the spoken word.

In addition, use of the micro-handset is essential in duplex operation to avoid acoustic coupling between microphone and loudspeaker.

Micro-telephonic handset equipment must therefore be provided for conversation. Loudspeakers on tractive units must only be used for calls or for listening to other communications (see point 4.2 - page 15).

## 3 - Frequency chart

(see Appendix A - page 47).

### 3.1 - Compilation of frequency chart

The frequency chart to be used for ground-train radio links is defined in Appendix A.

This chart has been compiled in accordance with the CEPT Recommendation T/R 22-01 which formalised the recommendations issued at the October 1971 Conference in Paris, attended by the UIC European Railways, with the participation of representatives and specialists from European GPO or Radio Administrations.

However, for the national bodies responsible for allocating frequencies, this recommendation does not have the obligatory status which would enable the Railways to rely on allocation of these bands. On the contrary, the allocation of frequencies must be requested and duly substantiated. Because of the use of frequencies by other radio users in the bands mentioned, it will generally only be possible to obtain allocation of a limited number of continuous frequencies in these bands. Allocation of complete bands to a Railway would be an ideal solution, but must be regarded as exceptional.

In certain countries too, these allocations are subject to certain restrictions, which differ from one country to another.

One restriction extending to international level must be mentioned here: frequencies 457,525; 457,550 and 457,575 MHz are allocated to shipping on the high seas and to inland waterways for ship-to-ship communications.

### 3.2 - Allocation of channels along international traffic lines

- **3.2.1** - Channels relating to lines crossing frontiers must be allocated after bilateral or multilateral agreement between administrations responsible for allocating frequencies on the proposal of the Railways of the countries concerned, and preferably from the frequency groups mentioned in point **3.8.1 - page 13**. If this is not possible, one of the groups mentioned in point **3.8.2 - page 13** will be used.

It must be remembered here that at frontiers or at frontier stations, traffic control transfers from one Railway to the other, which means that the quadrifrequency group must be changed at these points.

Change of coverage by the lineside stations and therefore also by the quadrifrequency groups shall be arranged as follows:

1. on lines with two frontier stations, it shall take place where the Railways terminate (national frontiers),
2. on lines with a common frontier station, it shall take place at that station.

Lineside installations located between the frontier and the common frontier station must be set up and operated in accordance with bilateral agreements specific to the common frontier station.

**O 3.2.2** - On frontier sections used by international traffic, the channels mentioned in points **3.8.1 - page 13** or **3.8.2 - page 13** shall be used, depending on the availabilities of the internal national charts for frequency allocation.

**R 3.2.3** - Generally speaking, frequencies are only allocated if the request is based on a concrete plan for use. It is recommended that a chart for ground-train radio links should be compiled as soon as possible, and a request made for the allocation of frequencies.

If such a chart cannot be compiled at present, talks should at least be initiated with the administrations responsible for the allocation of frequencies, with a view to reserving frequencies, given that there may no longer be any frequencies available in the near future.

### **O 3.3 - Common frequency bands**

For the requirements of ground-train radio links, the administrations responsible for allocating frequencies can only allocate them in the following bands:

- mobile transmitters: 457,400 MHz to 458,450 MHz
- lineside transmitters: band A 467,400 MHz to 468,450 MHz  
band B 447,400 MHz to 448,450 MHz

Band B is only to be used when it is not possible to use band A. In this case, special agreements must be entered into between Railways which exchange tractive units, concerning the additional equipment which the mobile apparatus must incorporate.

### **O 3.4 - Margin between adjacent channels**

The margin between nominal frequencies in these bands is 25 kHz.

### **O 3.5 - Duplex channels**

As indicated in point **2.12.1 - page 9**, the duplex channels are constituted by frequency pairs spaced 10 MHz apart. The frequencies of the lineside transmitters are 10 MHz above (band A) or below (band B) those of the mobile transmitters.

### **O 3.6 - Numbering of channels**

A standard numbering is prescribed to designate the duplex channels and the quadrifrequency groups. See frequency chart in Appendix **A - page 47**.

**3.6.1** - The numbering extends to 59 duplex channels, in which those with the lowest frequencies (No 1 to 8), and those with the highest frequencies (No 52 to 59) fall outside the bands mentioned in point **3.3**. They serve to extend the possibilities of allocating frequencies, particularly for lines not used by international traffic.

The numbering of duplex channels is also valid for simplex channels which are used for local radio links and are formed from duplex channels.

**3.6.2** - The quadrifrequency groups to be taken into consideration are designated by the numbers 60 to 67 and 70 to 79 (see Appendix **A**).

**3.6.3** - This numbering should be used in talks, exchanges of correspondence or agreements between Railways. It should also be used for indicating channels on the switching equipment of the apparatus on tractive units, and in working instructions intended for staff.

The purpose of this standard numbering is to avoid confusion during talks between Railways, and when using apparatus on tractive units in frontier zones between adjacent Railways.

## **R 3.7 - Intermodulation**

**3.7.1** - The groups numbered 60 to 67 have been set so that the corresponding frequencies of these 8 groups possess between them practically no intermodulation effect of the first or second order.

They are therefore particularly suited for use at rail centres where lineside stations serving several lines have to be installed at short distances from each other, a configuration which tends to produce intermodulation between channels.

**3.7.2** - The groups numbered 70 to 79 are not devoid of intermodulation effects.

When using these channels, it must be ensured, by careful selection of frequencies and distancing transmitters from each other, that the danger of intermodulation is adequately avoided (as user of the system).

## **o 3.8 - Preferential channels for international traffic lines**

**3.8.1** - Groups No 62, 63, 64 and 65 should preferably be used for serving international lines worked used by tractive units of adjacent Railways.

**3.8.2** - If this is not possible, groups No 73, 74, 75, 76 or 77 should be used.

**3.8.3** - If allocation of frequencies for groups designated in points **3.8.1** and **3.8.2** cannot be obtained, channels can be constituted from groups No 60, 61, 66, 67 or No 70 71, 72, 78 and 79, but this will require the agreement of all the Railways whose tractive units run over the line concerned. This agreement must guarantee the existence of the channel chosen on the switches of the apparatus on tractive units, in accordance with point **3.9.2**.

## **3.9 - Switching channels in apparatus on tractive units**

**o 3.9.1** - It must be possible for the frequencies designated below to be selected by the apparatus on tractive units. The selection of a channel, identified by its number, must activate simultaneous selection of the four constituent frequencies:

1. the quadrifrequency groups No 62, 63, 64 and 65 mentioned in point **3.8.1**,
2. the quadrifrequency groups No 73, 74, 75, 76 and 77 mentioned in point **3.8.2**.

**R 3.9.2** - It is recommended that the frequency groups No 60, 61, 66 and 67, as well as groups No 70, 71, 72, 78 and 79 should also be interposed in the channel switches.

In principle, these groups are intended to serve lines used solely for domestic traffic.

If these groups are used on lines with international traffic under cover of an agreement between the Railways concerned, their incorporation into the switches of the apparatus on tractive units is obligatory, in accordance with point **3.8.3 - page 13**.

- R 3.9.3** - It is recommended that the channel switches should be equipped so that they can select the largest possible number of duplex channels numbered 17 to 37 (see **Appendix A - page 47**).

The automatic switching device of the reception frequencies of the apparatus on tractive units must remain inoperative when these duplex channels are selected.

- R 3.9.4** - Bearing in mind obligatory or recommendatory possibilities of selection for those channel switches utilised in international traffic, and additional frequency-allocation possibilities for lines used solely for domestic traffic, it is recommended that the apparatus should be suitable for selecting all the channels contained in a bandwidth of 1 MHz, quartz only being installed if necessary.

## **R 3.10 - Simplex channels in apparatus on tractive units**

It is technically possible to install, in the apparatus on tractive units, an extra constituent block, so that the apparatus for simplex operations can be used by switching the reception frequency instead of the transmission frequency of each duplex channel fitted to the apparatus.

The radio equipment of tractive units can then be utilised for numerous other railway-specific radio applications, generally local ones.