



**Recommendation ITU-R M.1084-4**  
(08/2001)

**Interim solutions for improved efficiency  
in the use of the band 156-174 MHz by  
stations in the maritime mobile service**

**M Series**  
**Mobile, radiodetermination, amateur  
and related satellite services**

## Foreword

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*Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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## RECOMMENDATION ITU-R M.1084-4\*,\*\*

**Interim solutions for improved efficiency in the use of the band  
156-174 MHz by stations in the maritime mobile service**

(Question ITU-R 96/8)

(1994-1995-1997-1998-2001)

**Scope**

This Recommendation provides guidance to administrations on the possible use of channels narrower than 25 kHz as a means to alleviate congestion on Appendix 18 channels. Annex 1 provides technical parameters. Annex 2 is a guide to migrate from 25 kHz channels to narrower bands. Annex 3 documents a possible implementation method for 12.5 kHz channels.

The ITU Radiocommunication Assembly,

*considering*

- a) that Recommendation No. 318 (Mob-87) of the World Administrative Radio Conference for the mobile services (Geneva, 1987) (WARC Mob-87) seeks the most appropriate means to improve efficiency in the use of the RR Appendix 18 VHF frequency spectrum for maritime mobile communications;
- b) that a common international system is essential for maritime communications to ensure the safety of life at sea;
- c) that the greatest long-term benefits in spectrum efficiency will be gained by using the latest digital or narrow-band transmission techniques;
- d) that the introduction of new technology or replanning of frequency bands will be a significant exercise involving a long period of transition;
- e) that any new equipment needs to be compatible or be able to co-exist with existing equipment conforming to Recommendation ITU-R M.489 already in widespread use;
- f) that the introduction of new technology should not interrupt the continuous availability of RR Appendix 18 maritime mobile distress and safety communications in the VHF bands for all users;
- g) that congestion in the VHF maritime mobile band has become a serious problem in some parts of the world and is continuing to grow;
- h) that because of this need administrations may decide to take measures to solve their local congestion problem;

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\* This Recommendation should be brought to the attention of the International Maritime Organization (IMO).

\*\* Radiocommunication Study Group 5 made editorial amendments to this Recommendation in November 2010.

- j) that RR Appendix 18 makes provision for administrations having an urgent need to reduce local congestion to apply 12.5 kHz channel interleaving on a non-interference basis to 25 kHz channels;
- k) that the implementation of 12.5 kHz channels would require a standard channel numbering plan;
- l) that administrations are planning to implement single frequency operation of two frequency channels as a means of alleviating current congestion;
- m) that these interim solutions are used by the standard universal automatic identification system developed in accordance with Recommendation ITU-R M.1371 to meet IMO vessel carriage requirements,

*recommends*

- 1 that administrations having an urgent need to resolve congestion, should implement single frequency operation of two frequency channels as an interim expedient measure;
- 2 that, for administrations having an urgent need to resolve congestion, changing to 12.5 kHz analogue frequency modulation (FM) as an interim expedient would be a simple approach to improving spectrum utilization but could have an impact on current operations, especially where it involved international shipping using 25 kHz channel spacing;
- 3 that administrations, when employing 12.5 kHz analogue FM channels as an interim measure, should avoid distress and safety channels and channels affecting the safety of international shipping;
- 4 that the interim arrangements referred to in *recommends* 2 and 3 should not prejudice the implementation of the longer term solution resulting from the ongoing studies which may result in the use of advanced technologies and channelling of bandwidth other than 12.5 kHz;
- 5 that the interim arrangements referred to in *recommends* 2 and 3 shall not prejudice the implementation of a single international system for distress and safety communications by the international community in the longer term;
- 6 that administrations intending to resolve current congestion problems through the use of narrow-band channels should consider Annex 2 as a guide to migration from 25 kHz channels to narrower bands;
- 7 that administrations intending to resolve current congestion problems through the use of narrow-band channels should use equipment conforming to the technical parameters given at Annex 1, whilst taking into account the provisions of RR Appendix 18;
- 8 that administrations implementing interleaved narrow-band channels at 12.5 kHz offset spacing on an interim basis should consider Annex 3 as an example of a possible implementation method (different example methods are available with other characteristics than those described in Annex 3);
- 9 that administrations implementing narrow-band channels at 12.5 kHz should consider Annex 4 for numbering the new channels;
- 10 that administrations implementing single frequency operation of two frequency channels should consider Annex 4, Section 3, for numbering the channels;
- 11 that administrations should, as far as possible, look to the implementation of the latest digital or narrow-band techniques to meet future operational requirements and achieve the efficient use of the band 156-174 MHz.

## ANNEX 1

**Technical characteristics for equipment designed to operate  
in channels spaced by 12.5 kHz**

Use of equipment implementing these parameters listed below (see Note 1) should only be in accordance with the provisions of RR Appendix 18:

- the frequency tolerance for coast and ship station transmitters should not exceed 5 parts in  $10^6$ ;
- the frequency deviation should not exceed  $\pm 2.5$  kHz.

NOTE 1 – For information, other characteristics are based on European Telecommunications Standard (ETS) 300 086 published by the European Telecommunications Standards Institute (ETSI).

## ANNEX 2

**Migration to narrow-band channels in the maritime mobile service****1 Introduction**

This Annex considers how in future the maritime-mobile service might migrate to narrow-band channels spaced at 5 kHz or 6.25 kHz apart, using linear or digital modulation. Consideration is given to migration from 25 kHz channel spacing as used at present, and from 12.5 kHz if the latter was to be implemented as an interim measure by some administrations.

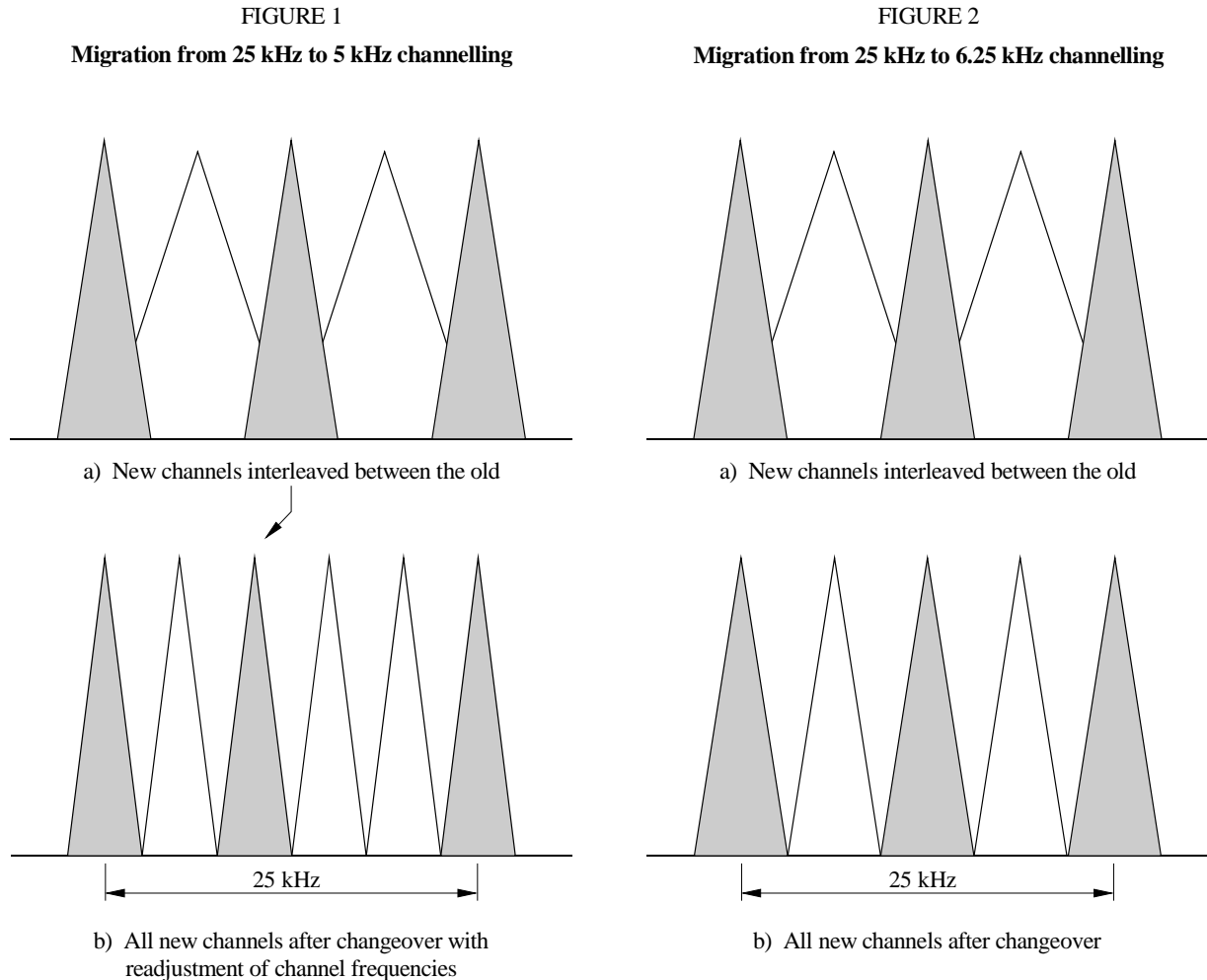
**2 Implications of migration to narrow-band channels****2.1 Migration**

The most practicable and least disruptive method of migrating from 25 kHz or 12.5 kHz to 5 kHz or 6.25 kHz would be by interleaving the narrow-band channels with the wider ones and a similar technique can be used in all cases. However because the linear and digital modulation techniques using 5 kHz and/or 6.25 kHz are incompatible with current FM equipment, dual mode or additional equipment would be required during the change-over period.

**2.2 Interleaving****2.2.1 Interleaving with 25 kHz channels**

Figures 1 and 2 illustrate how 5 kHz and 6.25 kHz channels could be interleaved with the existing 25 kHz ones. During the change-over period, coast stations and ships would be required to equip with narrow-band equipment and move to the new narrow-band channels as they became available. The numbers of new narrow-band channels would be gradually increased during the transition period with the number of 25 kHz channels available correspondingly decreasing.

On a specified date all remaining 25 kHz channels would be withdrawn to be replaced by new ones. The migration from 25 kHz channels is fairly straightforward but some realignment of channel or band edges is likely to be required.



1084-01

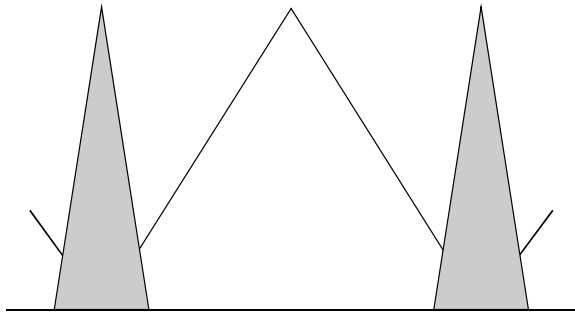
### 2.2.2 Interleaving with 12.5 kHz channels

Figures 3 and 4 show that the principle for interleaving 5 kHz or 6.25 kHz channels with any interim 12.5 kHz channels is exactly the same as for 25 kHz. However, the final transition is made more complicated in the case of 5 kHz as the channel initially interleaved on the centre of the 25 kHz band would have to be moved by 2.5 kHz.

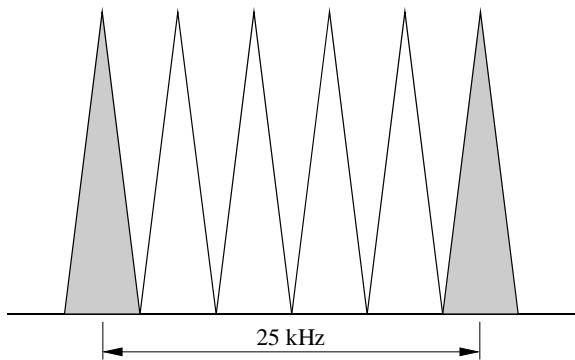
### 2.2.3 Interleaving with 25 kHz and 12.5 kHz channels

If some administrations were to move to 12.5 kHz channel spacing as an interim measure, and if the 12.5 kHz channels were interleaved with the 25 kHz channels, future migration to 5 kHz or 6.25 kHz channels would be significantly more complicated. As shown in Fig. 5, the new 5 kHz or 6.25 kHz channel would overlap one or other of the wider bandwidth channels.

FIGURE 3  
Migration from 12.5 kHz to 5 kHz channelling

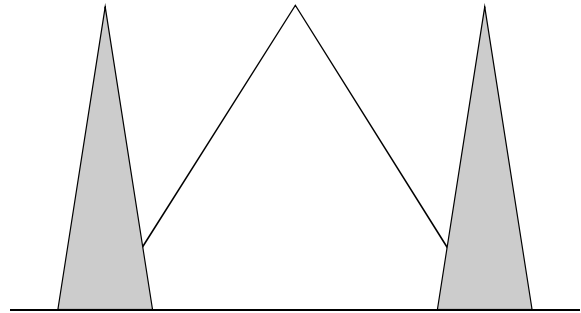


a) New channels interleaved between the old

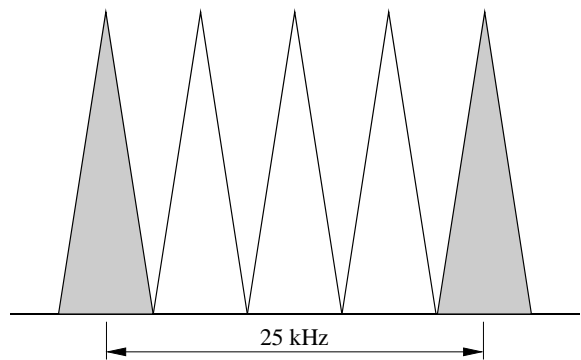


b) All new channels after changeover

FIGURE 4  
Migration from 12.5 kHz to 6.25 kHz channelling



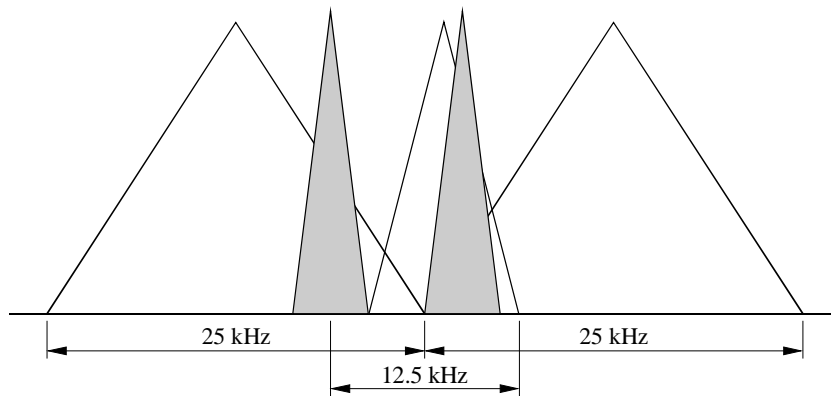
a) New channels interleaved between the old



b) All new channels after changeover

1084-03

FIGURE 5  
Inserting a new channel, 5 or 6.25 kHz, on top of 12.5 kHz channels already interleaved between 25 kHz channels, increases the overlap of transmissions. Two alternative cases are shown



1084-05



### 3 Interference

The interleaving process has to be done so as to minimize mutual interference. Some measurements of the interference and co-channel performance between interleaved linear modulation and 12.5 kHz FM have been made. No similar published information has been identified for narrow-band digital speech. It is however reasonable to assume that interleaving 5 kHz or 6.25 kHz channels between 25 kHz channels will lead to less interference and better co-channel performance than between 12.5 kHz channels.

### 4 Conclusions

The migration path to either 5 kHz or 6.25 kHz channels would be similar. However, a direct transition from 25 kHz rather than via an interim step of 12.5 kHz would be simpler in that:

- it would require less channel planning and realignment of centre frequencies;
- it would avoid channel overlap if 12.5 kHz channels were interleaved, as an interim measure, with 25 kHz ones; and
- the interference potential is likely to be less.

Clearly interleaving of channels will need to be carefully planned and the use of frequency planning tools will be important. Further field measurements and studies will be needed to provide the necessary information.

## ANNEX 3

### **An example method for implementing interleaved narrow-band channels at 12.5 kHz offset spacing**

This method could be used when 12.5 kHz operation is included along with digital selective-calling (DSC) operation (see Note 1) and 25 kHz in a single equipment.

NOTE 1 – DSC operation in this implementation is in full accordance with Recommendations ITU-R M.493, ITU-R M.541, ITU-R M.821 and ITU-R M.825.

#### 1 Receiver performance

**1.1** The sensitivity should be equal to or less than 0.3  $\mu$ V for a 12 dB signal plus noise plus distortion to noise plus distortion (SINAD) ratio at the output of the receiver for a 1 kHz narrow band frequency modulation (NBFM) modulation tone at 2 kHz peak deviation.

**1.2** Adjacent channel rejection should be at least 70 dB for a 12.5 kHz spaced adjacent channel.

**1.3** The spurious response and out-of-band rejection ratio should be at least 75 dB.



- 1.4** The radio-frequency intermodulation rejection ratio should be at least 75 dB.
- 1.5** The power of any conducted spurious emission, measured at the antenna terminals, should not exceed 2.0 nW at any discrete frequency.
- 1.6** The effective radiated power (e.r.p.) of any cabinet radiated spurious emission on any frequency up to  $\pm 70$  MHz removed from the carrier should not exceed 10 nW. More than 70 MHz removed from the carrier, the spurious emissions should not exceed 10 nW plus an additional  $-6$  dB/octave in frequency up to 1 000 MHz.
- 1.7** For receivers with DSC and C4FM capability. C4FM (constant envelope four-level FM) digital modulation in this implementation is compatible with CQPSK (compatible quadrature phase-shift key) modulation for both transmission and reception.
- 1.7.1** For DSC operation on 25 kHz channels, the receiver must be capable of error-free reception of any DSC data packet at  $0.3 \mu\text{V}$ .
- 1.7.2** For DSC operation on interleaved (12.5 kHz offset) channels, the receiver must be capable of error-free reception of a DSC data packet at  $0.3 \mu\text{V}$  at a reduced maximum deviation of  $\pm 2.5$  kHz.
- 1.7.3** For C4FM operation at 9 600 bit/s, the receiver must be capable of error-free reception of a data packet of 512 characters at  $0.5 \mu\text{V}$ . Forward error correction (FEC) may be applied to accomplish the error-free reception.

## **2 Transmitter performance**

- 2.1** The frequency tolerance for coast station transmitters should not exceed one part in  $10^6$  and that for ship station transmissions should not exceed five parts in  $10^6$ .
- 2.2** Spurious emissions on discrete frequencies, when measured in a non-reactive load equal to the nominal output impedance of the transmitter, should be in accordance with the provisions of RR Appendix 3.
- 2.3** The carrier power for coast station transmitters should normally not exceed 50 W (e.r.p.).
- 2.4** The carrier power for ship stations transmitters should not exceed 25 W and means should be provided to readily reduce this to 1 W or less for use at short ranges.
- 2.5** The frequency deviation should not exceed  $\pm 2.5$  kHz when transmitting on NBFM 12.5 kHz channels. The occupied bandwidth on these channels should not exceed 11 kHz. Deviation limiting circuits should be employed such that the maximum frequency deviation attainable should be independent of the input audio frequency. If a modulation switch is employed,  $\pm 5$  kHz deviation should be allowed for use on the wideband frequency modulation (WBFM) 25 kHz channels.
- 2.6** The upper limit of the audio-frequency band should not exceed 3 kHz.
- 2.7** The cabinet radiated power should not exceed  $25 \mu\text{W}$ .
- 2.8** Voice transmissions should be by means of standard maritime VHF FM with a 6 dB/octave pre-emphasis. This is necessary to ensure reliable, safe, interoperable communications on the high seas and in the waterways.

## 2.9 For transmitters with DSC and C4FM capability

**2.9.1** Transmitters with DSC capability should comply with the requirements of Recommendations ITU-R M.493, ITU-R M.541, and IMO A.803 (19) as a minimum. Stations should have provision for monitoring the VHF channel used for DSC purposes to determine the presence of a signal and, except for distress and safety calls, provide facilities for automatically preventing the transmission of a DSC call until the channel is free.

**2.9.2** DSC (1 200 bit/s) operation should be used at all times when operating on channel 70. Channel 70 should not be used as a working channel for any purposes. This channel should be kept as an international distress and calling channel. Passing of data for all other purposes such as data messaging, security monitoring, vessel tracking, and automated dependent surveillance (ADS) should be accomplished on another working channel.

**2.9.3** General purpose data transmission should be performed on both wideband 25 kHz channels and narrow-band interleaved (12.5 kHz offset) channels and should utilize the DSC protocol to the fullest extent practicable. Enhancements to the DSC protocol should be developed as needed and coordinated in order to maintain regulatory control and thus ensure interoperability between equipments from various manufacturers.

**2.9.4** DSC (1 200 bit/s) operation on narrow-band interleaved (12.5 kHz offset) channels should be at a reduced maximum deviation of  $\pm 2.5$  kHz.

**2.9.5** High speed (9 600 bit/s) data transmissions should be performed using C4FM modulation with baseband filter shaping.

### 2.9.5.1 C4FM modulation on 12.5 kHz offset frequency channels

The C4FM modulator consists of a Nyquist raised cosine filter, cascaded with a shaping filter, cascaded with a frequency modulator.

#### 2.9.5.2 C4FM Nyquist filter

The dibits of information (i.e., 4 800 symbols/s) are filtered with a raised cosine filter which satisfies the Nyquist criterion minimizing inter-symbol interference. The group delay of the filter is flat over the passband for  $|f| < 2 880$  Hz. The magnitude response of the filter is:

$$\begin{array}{lll} \text{approximately } 1 & \text{for} & |f| < 1\,920 \text{ Hz} \\ 0.5 + 0.5 \cos(2\pi f / 1\,920) & \text{for} & 1\,920 \text{ Hz} < |f| < 2\,880 \text{ Hz} \\ 0 & \text{for} & |f| \geq 2\,880 \text{ Hz} \end{array}$$

#### 2.9.5.3 C4FM shaping filter

The shaping filter has a flat group delay over the band-pass for  $|f| < 2 880$  Hz. The magnitude response of the filter for  $|f| < 2 880$  Hz is  $(\pi f / 4 800) / \sin(\pi f / 4 800)$ .

#### 2.9.5.4 C4FM frequency modulator

The deviation is +1.8 kHz for dibit 01, +0.6 kHz for dibit 00, -0.6 kHz for dibit 10, and -1.8 kHz for dibit 11.

## ANNEX 4

### Assignment of channel numbers to interleaved channels and simplex operation of duplex channels in the VHF maritime band

1 For channel number assignments to interleaved narrow-band channels at 12.5 kHz offsets:

First 25 kHz Channel	CHANNEL NUMBER		SHIP	SHIP & COAST	COAST
	Interleaved 12.5 kHz Channel	Second 25 kHz Channel			
01	260	60	156.025		160.625
				156.0375	160.6375
				156.050	160.650
02	261	61	156.075		160.675
				156.0875	160.6875
				156.100	160.700
03	262	62	156.125		160.725
				156.1375	160.7375
				156.150	160.750
04	263	63	156.175		160.775
				156.1875	160.7875
				156.200	160.800
05	264	64	156.225		160.825
				156.2375	160.8375
				156.250	160.850
06	265	65	156.275		160.875
				156.2875	160.8875
					156.300
07	266	66	156.3125		160.9125
				156.325	160.925
				156.3375	160.9375
08	267	67	156.350		160.950
				156.3625	160.9625
					156.375
08	268	68	156.3875		160.9875
				156.400	161.000
				156.4125	161.0125
		68	156.425		161.025
			156.4375		161.0375

First 25 kHz Channel	CHANNEL NUMBER		SHIP	SHIP & COAST	COAST
	Interleaved 12.5 kHz Channel	Second 25 kHz Channel			
09				156.450	
	209			156.4625	
		69		156.475	
10	269			156.4875	
				156.500	
	210			156.5125	DSC Guardband
11		70		156.525	<b>DSC Calling, distress &amp; safety</b>
	270			156.5375	DSC Guardband
				156.550	
12	211			156.5625	
		71		156.575	
	271			156.5875	
13				156.600	
	212			156.6125	
		72		156.625	
14	272			156.6375	
				156.650	
	213			156.6625	
15		73		156.675	
	273			156.6875	
				156.700	
16	214			156.7125	
		74		156.725	
	274			156.7375	
17				156.750	
	215			156.7625	
		75		156.775	Guardband
18	275			156.7875	Guardband
				<b>156.800</b>	<b>Calling, distress &amp; safety</b>
	216			156.8125	Guardband
19		76		156.825	Guardband
	276			156.8375	
				156.850	
20	217			156.8625	
		77		156.875	
	277			156.8875	
21			156.900		161.500
	218		156.9125		161.5125
		78	156.925		161.525
22	278		156.9375		161.5375
			156.950		161.550
	219		156.9625		161.5625

First 25 kHz Channel	CHANNEL NUMBER		SHIP	SHIP & COAST	COAST
	Interleaved 12.5 kHz Channel	Second 25 kHz Channel			
		79	156.975		161.575
	279		156.9875		161.5875
20			157.000		161.600
	220		157.0125		161.6125
		80	157.025		161.625
	280		157.0375		161.6375
21			157.050		161.650
	221		157.0625		161.6625
		81	157.075		161.675
	281		157.0875		161.6875
22			157.100		161.700
	222		157.1125		161.7125
		82	157.125		161.725
	282		157.1375		161.7375
23			157.150		161.750
	223		157.1625		161.7625
		83	157.175		161.775
	283		157.1875		161.7875
24			157.200		161.800
	224		157.2125		161.8125
		84	157.225		161.825
	284		157.2375		161.8375
25			157.250		161.850
	225		157.2625		161.8625
		85	157.275		161.875
	285		157.2875		161.8875
26			157.300		161.900
	226		157.3125		161.9125
		86	157.325		161.925
	286		157.3375		161.9375
27			157.350		161.950
	227		157.3625		161.9625
		87	157.375		161.975
	287		158.3875		161.9875
28			157.400		162.000
	228		157.4125		162.0125
		88	157.425		162.025

**2** Extension of channel number assignments for migration to 6.25 kHz channel spacing from the current 25 kHz channel spacing with interleaved 12.5 kHz offset frequencies channels: (This channel numbering sequence is provided as an example.)

	CHANNEL No. (6.25 kHz spacing)	SHIP	SHIP & COAST	COAST
	60	156.025		160.625
	160	156.03125		160.63125
	260	156.0375		160.6375
01	360	156.04375		160.64375
		156.050		160.650
	101	156.05625		160.65625
	201	156.0625		160.6625
	301	156.06875		160.66875
	61	156.075		160.675

**3** For channel number assignments to simplex operation of duplex channels: (This channel numbering sequence is provided as an example.)

CHANNEL No.	SHIP	SHIP & COAST	COAST
<b>For normal duplex operation:</b>			
60	156.025	–	160.625
<b>For simplex operation of ship station frequency:</b>			
1 060 (see Note 1)	–	156.025	–
<b>For simplex operation of coast station frequency:</b>			
2 060 (see Note 1)	–	160.625	–

NOTE 1 – This method of numbering a duplex channel used for simplex operation is in accordance with Recommendation ITU-R M.493, Annex 1, Table 13.

**4** For channel number assignments to narrow-band operation (12.5 kHz) on 25 kHz channels: (This channel numbering sequence is provided as an example.)

CHANNEL No.	SHIP	SHIP & COAST	COAST
<b>For normal channel operation:</b>			
60	156.025	–	160.625
<b>For 12.5 kHz operation on 25 kHz channel:</b>			
460	156.025	–	160.625