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DRAFT REVISION OF RECOMMENDATION ITU-R M.1084-3*

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)

Summary

This Recommendation provides for an interim measure to give immediate relief to administrations having urgent needs to resolve congestion. It cautions administrations to avoid distress and safety channels and other channels which may affect the safety of international shipping. The Recommendation also recognizes the need to continue studies leading toward a long-term solution to improving the efficiency using the band 156-174 MHz.

Annex 1 provides the technical characteristics for equipment designed to operate with 12.5 kHz channels in accordance with the provisions of this Recommendation and Appendix S18 to the Radio Regulations (RR).

Annex 2 illustrates how administrations could migrate, in the future, from existing 25 kHz spaced channels to 5 or 6.25 kHz spaced channels in the maritime mobile service band 156-174 MHz.

It also considers migration from 12.5 kHz spaced channels to cater for those administrations who may have introduced the channel spacing as an interim measure.

Annex 3 illustrates one method of implementing 12.5 kHz channels.

Annex 4 provides a channel numbering plan for implementation of 12.5 kHz channels. The Annex also provides for the implementation of 6.25 kHz channel numbering. In addition, the Annex provides for the implementation of simplex operation of duplex channels and narrow-band (12.5 kHz) operation on 25 kHz channels.

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

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 S18 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 S18 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;

j) that RR Appendix S18 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 ~~should not inhibit the introduction of a~~ standard universal shipborne automatic identification system ~~being~~ developed in accordance with ITU-R Recommendation M.1371 (series) to meet ~~in the~~ 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 S18;

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 S18:

– the necessary bandwidth should be 11 kHz;

– ~~the frequency tolerance for coast and ship station transmitters should not exceed 5 parts in 10^6;~~

– the frequency deviation should not exceed ±2.5 kHz.

NOTE 1 – 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

Figs. 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.

FIGURE 1

Migration from 25 kHz to 5 kHz channelling

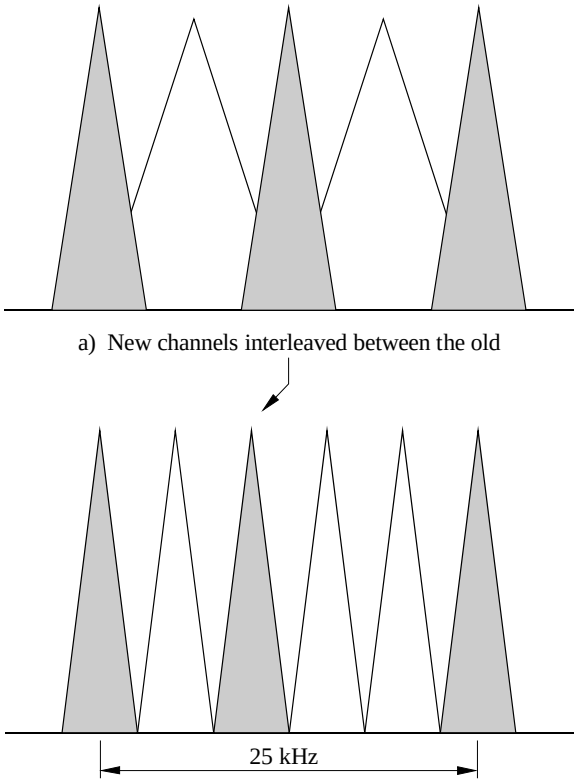
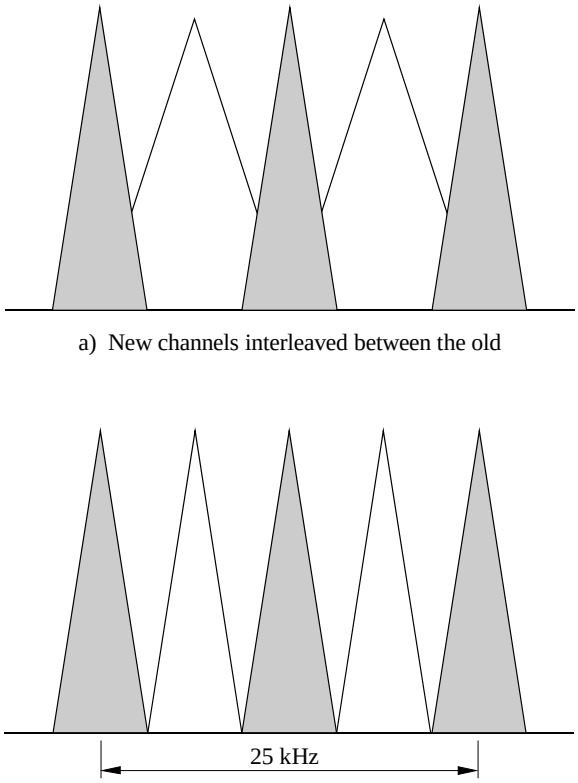


FIGURE 2

Migration from 25 kHz to 6.25 kHz channelling



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2.2.2 Interleaving with 12.5 kHz channels

Figs. 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.

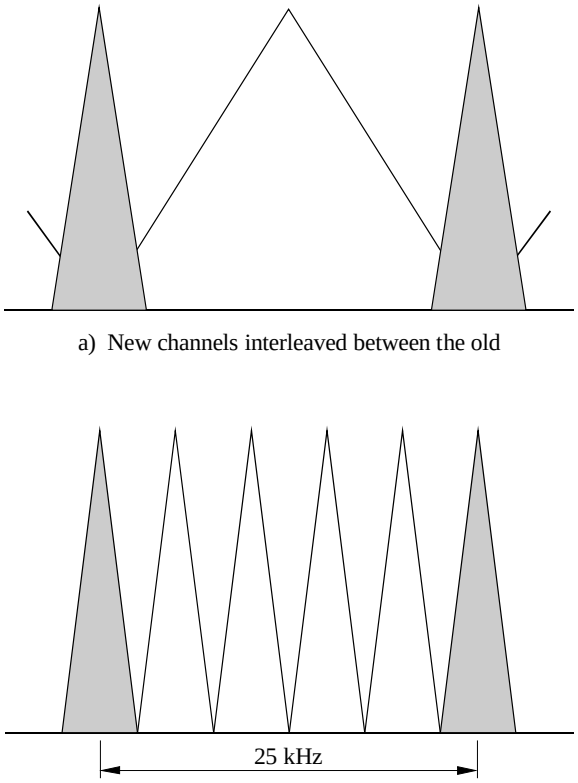
3 Interference

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.

FIGURE 3

Migration from 12.5 kHz to 5 kHz channelling

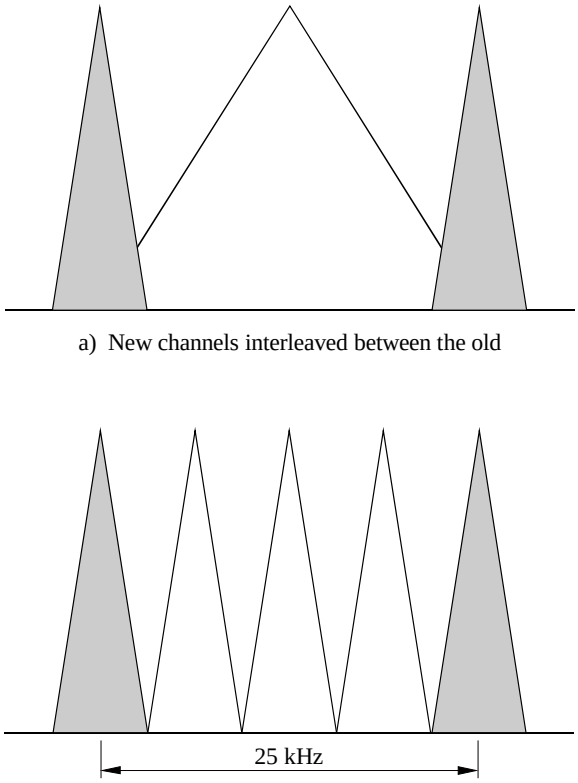


a) New channels interleaved between the old

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

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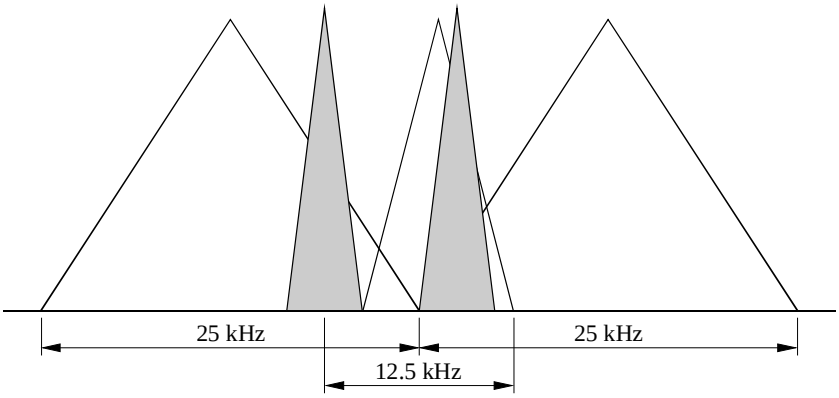
FIGURE 5

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



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 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 μv 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 frequence 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 ±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 μV.

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 μV at a reduced maximum deviation of ±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 μV. 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 S3.

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 ±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, ±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 μW.

2.8 Voice transmissions should be by means of standard maritime VHF FM with a 6 dB/octave pre-emphasis. This is necessary to insure 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 ±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:

approximately 1	for	$\lvert f\rvert < 1\,920$ Hz
$0.5 + 0.5 \cos (2\pi f / 1\,920)$	for 1 920 Hz	$< \lvert f\rvert < 2\,880$ Hz
0	for	$\lvert f\rvert \geq 2\,880$ Hz.

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:

CHANNEL NUMBER			SHIP	SHIP & COAST	COAST
First 25 kHz Channel	Interleaved 12.5 kHz Channel	Second 25 kHz Channel			
		60	156.025		160.625
	260		156.0375		160.6375
01			156.050		160.650
	201		156.0625		160.6625
		61	156.075		160.675
	261		156.0875		160.6875
02			156.100		160.700
	202		156.1125		160.7125
		62	156.125		160.725
	262		156.1375		160.7375
03			156.150		160.750
	203		156.1625		160.7625
		63	156.175		160.775
	263		156.1875		160.7875
04			156.200		160.800
	204		156.2125		160.8125
		64	156.225		160.825
	264		156.2375		160.8375
05			156.250		160.850
	205		156.2625		160.8625
		65	156.275		160.875
	265		156.2875		160.8875
06				156.300	
	206		156.3125		160.9125
		66	156.325		160.925
	266		156.3375		160.9375

CHANNEL NUMBER			SHIP	SHIP & COAST	COAST
First 25 kHz Channel	Interleaved 12.5 kHz Channel	Second 25 kHz Channel			
07			156.350		160.950
	207		156.3625		160.9625
		67		156.375	
	267			156.3875	
08				156.400	
	208			156.4125	
		68		156.425	
	268			156.4375	
09				156.450	
	209			156.4625	
		69		156.475	
	269			156.4875	
10				156.500	
	210			156.5125	DSC Guardband
		70		156.525	DSC Calling, distress & safety
	270			156.5375	DSC Guardband
11				156.550	
	211			156.5625	
		71		156.575	
	271			156.5875	
12				156.600	
	212			156.6125	
		72		156.625	
	272			156.6375	
13				156.650	
	213			156.6625	
		73		156.675	
	273			156.6875	
14				156.700	
	214			156.7125	
		74		156.725	
	274			156.7375	
15				156.750	
	215			156.7625	
		75		156.775	Guardband
	275			156.7875	Guardband

CHANNEL NUMBER			SHIP	SHIP & COAST	COAST
First 25 kHz Channel	Interleaved 12.5 kHz Channel	Second 25 kHz Channel			
16				156.800	Calling, distress & safety
	216			156.8125	Guardband
		76		156.825	Guardband
	276			156.8375	
17				156.850	
	217			156.8625	
		77		156.875	
	277			156.8875	
18			156.900		161.500
	218		156.9125		161.5125
		78	156.925		161.525
	278		156.9375		161.5375
19			156.950		161.550
	219		156.9625		161.5625
		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

CHANNEL NUMBER			SHIP	SHIP & COAST	COAST
First 25 kHz Channel	Interleaved 12.5 kHz Channel	Second 25 kHz Channel			
25			157.250		161.850
	225		157.2625		161.8625
		85	157.275		161.875
	285		157.2875		161.8875~~900~~
26			157.300		161.900~~125~~
	226		157.3125		161.9125
		86	157.325		161.92~~37~~5
	286		157.3375		161.9375~~0~~
27			157.350		161.950~~625~~
	227		157.3625		161.962~~7~~5
		87	157.375		161.9~~8~~75
	287		157~~8~~.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
360			156.04375		160.64375
01			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
For normal duplex operation:			
60	156.025	–	160.625
For simplex operation of ship station frequency:			
1 060 (see Note 1)	–	156.025	–
For simplex operation of coast ~~ship~~ station frequency:			
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 narrowband operation (12.5 kHz) on 25 kHz channels: (This numbering sequence is provided as an example.)

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