

## REPORT 1161

USE OF MF/HF DSC FOR AUTOMATIC CONNECTION OF CALLS  
IN THE MARITIME-MOBILE SERVICE MF AND HF BANDS TO  
THE PUBLIC SWITCHED NETWORK

(Question 93/8)

(1990)

1. Introduction and background

The facility for inserting the public switched network number in a Digital Selective Calling (DSC) call (see Recommendation 493, Annex I § 8.2.3) has enabled an automatic (direct-dial) telephone system to be introduced in the VHF band, using the existing Appendix 18 working channels, based on the operational procedures which are described in draft Recommendation 689.

1.2 This report examines the MF/HF situation and proposes that such an automatic system (with some modifications compared to the VHF system) may indeed be introduced on MF/HF frequencies.

2. Factors which differ between MF/HF and VHF

2.1 For an automatic system based on DSC the main factors which differ between MF/HF and VHF are as follows:

2.1.1 The modulation rate of DSC on MF/HF is 100 baud compared to 1200 baud on VHF. This results in the duration of a single DSC VHF automatic call taking a maximum of 0.633 seconds (assuming an 18 digit telephone number) whereas an equivalent call on MF/HF would take 8.2 seconds (assuming a 20-bit dot pattern and two elements in the channel/frequency message).

2.1.2 The probability of a single DSC transmission on MF/HF being received error-free by a particular receiving station will, in general, be lower than at VHF (typically 60% on HF; 95% on MF (day); 100% on VHF as given in CCIR Report 501).

2.1.3 The class of emission on MF/HF radiotelephony working channels is J3E (suppressed carrier) whereas on VHF it is F3E/G3E (i.e. a carrier is present even when the transmitter is not being modulated).

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\* The Director, CCIR, is requested to bring this Report, in particular section 3, to the attention of the CCITT.

2.1.4 A DSC call on an MF or HF frequency can, in general, be received at a greater distance than that over which a radiotelephony call can be received, due mainly to the narrower bandwidth of the DSC transmission, whereas on VHF the ranges of a DSC call and a radiotelephony call are substantially the same. Furthermore, the channel quality of MF and HF working channels is generally poorer than VHF channels.

2.2 These differences mean that for MF/HF operation some modifications would be needed to the operational procedures described in draft new Recommendation 689. The three main factors to be considered are: the suppressed carrier operation on MF/HF working channels; the possibility of receiving a DSC call at a distance over which a subsequent radiotelephony call could not be received; and the need to ensure that the working channel quality is adequate for the required communication.

2.3 It is also considered that the automatic DSC call repetition (in the event of an unsuccessful first call) which is included in draft new Recommendation 689 would not provide any significant benefit due to the longer duration of an MF/HF DSC call. Only manually initiated repeats are therefore proposed.

2.4 Various methods of evaluating the working channel quality may be applicable and require further study. One method could be to measure the signal-to-noise (S/N) ratio on the working channel and to compare this to the required working channel S/N ratio appropriate to the mode of communication required. Recommendation 339 (Volume III) gives typical RF S/N density ratios (dB/Hz) of various classes of emission and may be used to determine the appropriate working channel S/N ratios for the desired mode. For example, an F1B 100 baud 300 Hz bandwidth telegraphy emission (which may be considered analagous to an MF/HF DSC emission) is stated as requiring an RF S/N density ratio of 43 or 52 dB/Hz (for stable or non-diversity fading conditions respectively), whereas a corresponding J3E telephony emission for a marginally commercial grade of service is stated as requiring 56 or 61 dB/Hz (for the same conditions as above).

2.5 The fact that quality (the DSC S/N ratio) is measured only in the ship-to-shore direction presupposes a symmetrical path.

Even allowing the following assumptions:

- identical transmission and reception antenna gain at the coast station;
- identical transmission and reception antenna gain at the ship station;
- identical receiver sensitivity at both stations,

the fact nevertheless remains that:

- transmission power is higher at the coast station;
- noise is higher on board the ship.

It may be that those two phenomena more or less cancel each other out.

However, measuring the DSC S/N ratio in both directions would involve:

- increased length of the procedures;
- greater cost of equipment on board each ship.

This explains why no such procedure has been adopted.

2.6 While ship stations normally have only one radio set to cover the MF and HF frequency bands to provide the following successive functions:

- watching or calling;
- exchanging procedures;
- traffic handling,

the same does not apply to coast stations which usually have several equipments for these frequency bands.

There is no reason why the equipments at the coast station should not be specialized, some being reserved for the first two functions and all the others for traffic handling.

Omnidirectional antennas are used in HF for the first two functions but directional antennas can be used, by some coast stations, for the third.

The number of simultaneous telephone calls that can be made from the coast station is thus equal to the number of traffic equipments.

A permanent watch is kept on DSC frequencies and, when all the traffic equipments are in use, it is possible to answer a call and indicate temporary unavailability.

### 3. Conclusions and further study

3.1 Automatic operation on MF/HF frequencies appears to be feasible. Proposed operational procedures are given in Annex I but require further study. The extent to which these procedures may be applicable to the use of a working channel instead of a DSC calling channel could also be studied.

3.2 In particular, the need for the ship station to be able to change frequency from a DSC channel to any other working frequency in the same band within 5 seconds should be studied. A longer time, e.g. 15 seconds, may be required.

3.3 Study of a definition for the "channel engaged" signal is also desirable.

## ANNEX I

## OPERATIONAL PROCEDURES

1. Introduction

These procedures are initiated by using DSC on an appropriate MF or HF paired DSC calling channel and based on the technical characteristics and operational procedures detailed in Recommendations 493 and 541.

Connection to the public switched telephone network is effected using any appropriate MF or HF public correspondence working channels listed in Article 60 of the Radio Regulations without in any way impairing their use for manual operations. The same working channel can be used for both automatic and manual operation by the same coast station depending on the requirements of the ship stations.

Appendix I illustrates the timing of the call set-up, calling and acknowledgement sequences described by these procedures.

Appendix II details the required technical characteristics of the ship and coast station equipment.

2. Operational procedures in the ship-to-shore direction2.1 Ship station initiates call

2.1.1 The user aboard the ship (hereafter referred to as the user) composes the calling sequence (see Note 1) on his DSC equipment as follows:

- selects the format specifier 123 (individual station automatic/semiautomatic service);
- enters 9-digit address (identification) of required coast station;
- selects the category routine (100);
- (the ship station self-identification is entered automatically);
- selects first and second telecommands as appropriate (for a normal radiotelephone call these would be 109 (J3E) and 126 (no information) respectively);
- inserts required working frequency/ies or channel number if required or ship's position (see Note 2);
- inserts the required subscriber number (e.g. telephone number);
- selects "end of sequence" signal "RQ":

Note 1 - It is assumed that commercial equipment will be produced which simplifies the composition of the calling sequence. In practice the user should only need to key the coast station address and the required subscriber number, all other information being inserted automatically.

Note 2 - Under normal circumstances the user should not insert the required working frequency/ies or channel number. It is assumed that the ship can operate on any public correspondence frequency/channel used by the addressed coast station. Only if a ship wishes to use a specific working channel should the frequency/ies or channel number be inserted by the user. Normally, the ship should insert its position so that the coast station can use this information to select the working channel and/or directional antennas. In the absence of any information, the symbol 126 will be automatically inserted 6 times (see Recommendation 493, Annex I, § 8.2.2 Note, and Table VII).

2.1.2 The user selects the MF or HF DSC ship-to-shore calling frequency appropriate to the coast station and frequency band through which he wishes to communicate and transmits the calling sequence, after checking as far as possible that there are no DSC calls in progress on that frequency.

2.1.3 If the ship station does not receive an error-free acknowledgement from the called coast station on the paired DSC shore-to-ship frequency (see § 2.2) within 25 s, the user should:

- in the case of MF, repeat the transmission of the DSC call in accordance with § 2.1.2;
- in the case of HF, either repeat the transmission of the DSC call on the same frequency or initiate a call on another DSC frequency (which may prove better from the propagation standpoint than the frequency initially chosen).

## 2.2 Coast station acknowledgement

### 2.2.1 Case in which the coast station can comply immediately with the call request

2.2.1.1 If, on the receipt of an error-free calling sequence, the coast station can comply immediately with the call request, then it should, within 3 s of receiving it, transmit an acknowledgement sequence on the paired DSC shore-to-ship frequency.

The acknowledgement sequence should contain the same information as in the call request, with the following exceptions:

- the address will be that of the ship;
- the self-identification will be that of the coast station;
- the working frequency/ies or channel number will be included regardless of whether this was included in the call request and should be normally in the same band as that of the received DSC call;
- the "end of sequence" signal will be "BQ".

2.2.1.2 If the coast station is unable to comply on the working frequency suggested but able to comply immediately on an alternative frequency, the acknowledgement sequence should be as in § 2.2.1.1 including an alternative working frequency.

2.2.1.3 After receiving the calling sequence, the coast station should within 10 seconds switch to the working frequency/ies indicated and then transmit an "engaged channel" signal on the working channel transmission frequency. In the case of an HF link, if the coast station uses directional antennas, it is possible to set up a transmission chain (one transmitter + one transmitting antenna + one receiver + one receiving antenna) corresponding to the geographical location of the ship station.

2.2.1.4 After receiving the sequence, the ship station should within 5 seconds switch to the working frequency/ies indicated.

## 2.2.2 Cases where the coast station cannot comply immediately with the call request

2.2.2.1 If the appropriate working frequency/ies or channel(s) are busy then the acknowledgement sequence should be as in § 2.2.1.1 except that the first telecommand should be 104 (unable to comply) and the second telecommand should be 102 (busy), no subscriber number should be included, and:

- if no working frequency/ies or channel was included in the call request then no working frequency/ies or channel should be included in the acknowledgement; or
- if a working frequency/ies or channel was included in the call request then that working frequency/ies or channel should be included in the acknowledgement.

2.2.2.2 If a working frequency/ies or channel was included in the call request but this frequency/ies or channel is not equipped for automatic operation at the coast station, then the acknowledgement should be as in § 2.2.2.1 but the second telecommand should be 108 (unable to use proposed channel).

2.2.2.3 If the coast station cannot comply for other reasons, the acknowledgement sequence should be as in § 2.2.2.1 except that the second telecommand signal should be one of symbol numbers 100 - 109 as appropriate.

2.2.3 The ship station, on receipt of an acknowledgement indicating "unable to comply" in accordance with § 2.2.2.1, 2.2.2.2 or 2.2.2.3 should, if an automatic connection is still required, initiate an appropriate new DSC call in accordance with § 2.1.

2.2.4 If the coast station transmitted an acknowledgement indicating "unable to comply"-in accordance with § 2.2.2.1, 2.2.2.2 or 2.2.2.3, then it should take no further action with respect to the call request.

## 2.3 Procedures subsequent to the exchange of initial DSC calls

2.3.1 Once tuned to the working frequency/ies indicated (see § 2.2.1.4), the ship station transmits on the ship-to-shore frequency of the working channel a DSC call identical to the initial call (see § 2.1.1).

If a DSC call containing the same self-identification as that of the calling ship is received on the coast station receive frequency of the working channel within 25 s, the coast station may, on the receipt of an error-free calling sequence, automatically measure the signal-to-noise (S/N) ratio of the received DSC call and compare this to the required S/N ratio appropriate to the mode requested (see Note ).

**Note** - Recommendation 339, Table I (Volume III) indicates that an RF S/N density ratio of  $> 61$  dB/Hz should be obtained for a J3E telephony call having a marginally commercial grade of service under non-diversity fading conditions. S/N density ratios applicable to other classes of emission can also be obtained from this table. The quality of the working channel may alternatively be estimated by other methods.

2.3.2 The coast station should then initiate the transmission of a DSC acknowledgement, within 5 s, on the shore-to-ship frequency of that working channel.

2.3.2.1 If the working channel quality evaluation indicates that the communication on the working channel will be satisfactory, then the acknowledgement should be identical to that transmitted in accordance with § 2.2.1.1. The coast station should then commence dialling the subscriber number.

2.3.2.2 If the working channel quality evaluation indicates that the communication on the working channel will not be satisfactory, but the coast station can offer an alternative working channel, then the acknowledgment should be identical to that transmitted in accordance with § 2.2.1.2 and the procedure should be repeated from § 2.3.1.

2.3.2.3 If the working channel quality evaluation again indicates that the communication on the new working channel will not be satisfactory, or if the coast station cannot offer an alternative working frequency, then the acknowledgement should be the same as that transmitted in § 2.2.1.1 except that the first telecommand should be 104 (unable to comply) and the second telecommand should be 108 (unable to use proposed channel).

2.3.3 If no such DSC call is received within 25 s then the coast station should remove the "engaged channel" signal from the working channel.

2.3.4 If the coast station transmitted an acknowledgement indicating "unable to comply" in accordance with § 2.3.2.2, then it should remove the "engaged channel" signal from the working channel and take no further action with respect to the call request.

2.3.5 If the ship station receives an "unable to comply" acknowledgement in accordance with § 2.3.2.2 or if it receives no acknowledgement within 25 s from the start of transmission of the call described in § 2.3.1 and hears no indication that the connection to the requested subscriber has been effected, then the ship station should clear the call in accordance with § 2.5.1.

## 2.4 Call connection

2.4.1 Once the coast station begins dialling the subscriber number it should connect the line circuit to the radio path. Timing of the call for billing purposes should commence after the subscriber answers, i.e. "off-hook" condition detected.

2.4.2 If the called subscriber does not answer within a period of one minute from completion of dialling or if anything other than ringing tones are received (e.g. engaged, number unobtainable, etc.), then the call should be considered as not started and the coast station should clear the circuit by disconnecting the line and radio circuit. The user, on hearing the ringing tones stop or hearing anything other than "ringing" tones, should refrain from any further transmissions on the working channel. If a further call is required, the user should initiate a new call on the DSC calling channel.

## 2.5 Call completion

2.5.1 When the ship station wishes to terminate the call connection to the subscriber it transmits an "end of call" DSC call on the ship-to-shore frequency of the working channel. The format of this call should be the same as that described in § 2.1.1 except that the first telecommand should be 105 (end of call) and the second telecommand should be 126.

2.5.2 On receipt of that call, if it contains the same self-identification as that of the calling ship, the landline is disconnected, the call timing is stopped and the coast station transmits a DSC acknowledgement on the shore-to-ship frequency of the working channel within 1 s of receipt. The format of that acknowledgement should be the same as that described in § 2.5.1 except that the "end of sequence" signal should be "BQ" and:

- i) the chargeable duration of the call should be inserted in the "frequency/channel" field by coding the first three characters as hours, minutes, seconds and the remaining three characters as symbols 126: e.g. a chargeable duration of 6 minutes and 50 s would be coded as 00 06 50 126 126 126;
- ii) if the chargeable duration of the call is not available, then the "frequency/channel" field should contain six symbols 126.

2.5.3 If the ship station does not receive an "end of call acknowledgement" within 20 s then it should repeat the "end of call" and consider the call to be complete.

2.5.4 If the coast station does not receive the "end of call" as described in § 2.5.2 then the call will be considered to be complete when the "on-hook" condition is detected from the public switched network (or if no reply within one minute or anything other than ringing tones are received). When this indication is registered at the coast station the following action should take place:

- call timing is stopped;
- the line is cleared and disconnected from the radio circuit;
- the coast station transmits an "end of call" DSC call whose format is the same as that of the acknowledgement described in § 2.5.2 except that the "end of sequence" signal should be 127;
- the coast station ceases transmissions on the working channel.

The radio channel is now free to handle other traffic.

2.5.5 Some coast stations may supplement the "on-hook" condition detection with an "absence of speech" detection system operating on the line circuit to provide additional protection against call clear malfunction.

2.5.6 If a further call is received from the same ship before call completion is recognized by the coast station, then the coast station could use the information derived from the call to disconnect the previously allocated working channel.

2.5.7 If further calls are required by the ship then a new call should be initiated on the DSC calling channel.



### 3. Operational procedures in the shore-to-ship direction

The following procedures may be used but require further study in order to cater for automatic operation from the public switched network.

One method would be to allow the coast station, after an initial call, to perform procedures identical to those described for ship-to-shore operation.

All the procedures described above then remain valid and are preceded by a call from the coast station containing information similar to that indicated in § 2.1.1 (the telephone number inserted being that of the calling subscriber).

Since the call and its reception on board the ship take no longer than 10 s, the times indicated in Appendix I should be increased by 10 s.

#### 3.1 Use of MF

Coast stations have only one DSC frequency on which the ship is expected to keep watch.

#### 3.2 Use of HF

Coast stations have access to several DSC frequencies (see Article 4684 of the Radio Regulations) corresponding to the different frequency bands allocated to the HF maritime-mobile service.

- a) If the ship "subscribes" to a given coast station, it keeps watch on the DSC frequency corresponding to the best probability of reception, at the time in question, of a transmission from the coast station. If, as is most frequently the case, the coast station does not know the ship's position, it should send an initial call on the different DSC frequencies.
- b) If the ship wishes to be able to receive calls from any coast station, or on more than one DSC frequency from the same coast station, it should keep watch on all the DSC frequencies and will thus require either as many receivers as there are frequencies or a scanning receiver.

## APPENDIX I

Timing diagram of call set-up sequences

(Maximum timing)

Time (s)	Ship	Coast station
0	Transmit DSC call (§ 2.1.2).	
10	.....	Receive call.
13	.....	Transmit DSC acknowledgement (§ 2.2.1.1 or 2.2.2). Switch to the working frequencies (§ 2.2.1.3), after setting up transmission chain in the HF case.
20	.....	When tuned to working frequencies transmit "engaged channel" signal.
23	Receive DSC acknowledgement. Switch to working frequencies (§ 2.2.1.4).	
25	If no DSC acknowledgement received then transmit new call (§ 2.1.3). Go to time 0.	
28	If DSC acknowledgement "able to comply" received, transmit DSC call on working channel (§ 2.3.1).  If DSC acknowledgement "unable to comply" received, initiate appropriate new call if required (§ 2.2.3). Go to time 0.	
38	.....	Receive DSC call and then measure channel quality (§ 2.3.1), or if no DSC call received remove "engaged channel" signal (§ 2.3.3).
43	.....	If channel quality satisfactory then transmit acknowledgement (§ 2.3.2.1). If channel quality not satisfactory then transmit acknowledgement (§§ 2.3.2.2 and 2.3.2.3).

Note - Timing diagram assumes the following:

- i) 10 s between DSC call initiation and reception of the complete DSC call (maximum duration of a DSC call will be 8.2 s);
- ii) maximum timing between calls and acknowledgements;
- iii) 5 s is the maximum time required for ship to change from DSC channel to working channel in the same band;
- iv) 10 s is the maximum time required for coast station to change from DSC channel to working channel;
- v) coast station not offering alternative working frequency.

## APPENDIX II

### Technical characteristics

#### 1. Ship station

1.1 The DSC equipment should meet the MF/HF technical characteristics detailed in Recommendation 493. This equipment need not necessarily provide all combinations of codes, e.g. it may be simplified DSC equipment (with no distress functions), but it must provide all the necessary formats for automatic/semi-automatic MF/HF DSC signalling.

1.2 The MF/HF transceiver should be capable of operating on any of the MF/HF public correspondence working channels and on any MF/HF DSC calling channel listed in Article 60 of the Radio Regulations which may be operated by the coast station(s) through which automatic operation is required. It should be capable of automatic channel selection under control of the DSC equipment and of changing frequency from a DSC channel to any other working frequency in the same band within 5 s.

1.3 The equipment should be capable of operating in accordance with the operational procedures described in this annex.

#### 2. Coast station

2.1 The DSC equipment should meet the MF/HF technical characteristics detailed in Recommendation 493. The installation should be capable of receiving and transmitting all types of MF/HF DSC calls on a DSC calling channel.

2.2 The MF/HF installation should be capable of operating on the coast station's designated public correspondence working channels and DSC calling channels.

2.3 The coast station equipment should be capable of detecting the presence of a DSC call on the working channel and the subscriber's "off-hook" and "on-hook" conditions.

2.4 The equipment should be capable of effecting automatic channel selection on instruction from the DSC equipment and changing to, or accessing, a working frequency in less than 10 s.

2.5 The coast station should be capable of radiating an "engaged channel" signal on any of its working channels which should be dissimilar from any present line signalling tones.

2.6 The equipment should be capable of operating in accordance with the operational procedures described in this annex.

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REPORT 1029

THE FUTURE USE OF THE BAND 2170-2194 kHz

(Questions 29-1/8 and 66/8)

(1986)

**1. Introduction**

1.1 Resolution 204 of the World Administrative Radio Conference for the Mobile Services (Geneva, 1983) invited the CCIR to study the selection of frequencies for routine (non-distress) voice calling and digital selective calling (DSC) in the band 2170-2194 kHz.

1.2 This Report considers the minimum frequency separation likely to be needed between a DSC channel and a telephony channel to avoid mutual degradation, taking account of the probable rejection characteristics of the receivers and the ratio of transmitter powers likely to be experienced in practice.