REPORT 744-2 *

USE OF CLASS J3E EMISSIONS FOR DISTRESS AND SAFETY PURPOSES

(Question 26/8)

(1978-1982-1986)

1. Introduction

This Report discusses the use of class J3E emissions for distress and safety purposes on the carrier frequency 2182 kHz. The use of J3E emissions for distress and safety purposes on the carrier frequencies 4125 kHz and 6215.5 kHz is the subject of Recommendation 544. Recommendation 543 recommends that class R3E emission should not be used for distress and safety purposes.

IMO recognized the significant advantages in using the class of emission J3E and the desirability of using it for distress and safety communications [IMO, 1980a and b].

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* The Director, CCIR, is requested to draw the attention of the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO) to this Report and invite their comments on this matter.

One of the major problems in the past was the compatibility of A3E, H3E and J3E alerting emissions on 2182 kHz. In the new distress and safety system mentioned below it is envisaged to discontinue the use of the alerting function of 2182 kHz. Under this new system, the alerting function would be provided by digital selective calling on 2187.5 kHz.

Nevertheless, this Report contains also the compatibility considerations for alerting on 2182 kHz, for the case where these considerations might still be useful for IMO when deliberating on the transitional plan.

However, the general introduction of J3E should not be realized before the Future Global Maritime Distress and Safety System becomes operational.

IMO has prepared the operational requirements for the Future Global Maritime Distress and Safety System and was of the opinion that for this system, based on the use of automatic digital selective-calling alerting techniques, new equipment will need to be designed and manufactured for ships and survival craft. This new equipment will need to work with closer frequency tolerances and to higher technical standards than existing equipment.

2. Operational considerations

2.1 The main operating advantage in using class J3E emission for distress is a power budget saving or alternatively an improved range of communications. Reliability and economy of ships's equipment would be enhanced because distress and commercial communication channels would use the same class of emission. There would also be an improvement in the utilization of frequency spectrum. However, there are large numbers of existing survival craft equipment, portable distress equipment and EPIRBs which use A3E or H3E emissions.

2.2 Recommendation 488 implies that for a given primary input power, the use of J3E would improve the range of operation of the equipment. This has been confirmed by practical experience. In a distress situation the greatest possible communication range is desirable.

2.3 Conversely, Recommendation 488 indicates that, for the same signal/noise ratio, a peak envelope power saving of approximately 10 dB could be achieved by the use of J3E compared with A3E or H3E. Such a saving would be particularly attractive where limitations of space and weight could impose serious problems. These circumstances apply to radio equipment intended for use in survival craft and for other mobile and portable equipment which is battery operated.

2.4 The atmospheric noise levels in temperate zones and the packaging constraints for 2182 kHz survival craft equipment and EPIRBs reduce their effectiveness in those zones.

3. Radio direction finding and homing on signals of classes of emission J3E and F1B

Present radio direction finding equipments in ships and coast stations are designed to locate emissions of a carrier with unvarying sidebands of sufficient duration to obtain a bearing. In this respect provisions 3119 and 3140 of the Radio Regulations are to be noted. The Future Global Maritime Distress and Safety System (FGMDSS) will include single-sideband emissions with suppressed carrier while maritime mobile stations will be equipped with single-sideband transmitters and with equipment for narrow-band direct printing (F1B) emissions.

Provision should be made so that in the FGMDSS the location of, and homing on J3E and F1B emissions is possible. Therefore, circuitry which would allow homing on J3E signals should be considered in the development of new MF/HF radio direction-finding equipment.

Studies are therefore urgently required on the technical and operational aspects of direction finding and homing on any of the frequencies that are envisaged for distress and safety purposes in the FGMDSS and on the emissions which will be employed on those frequencies.

Most MF and HF direction-finding equipment currently used, normally rely on a continuous carrier or signal to accurately determine a bearing. By its nature, a J3E voice modulated signal is not suitable for direction-finding using such equipment. When a rescue vessel desires to locate a vessel in distress, the radio operator on the vessel in distress should have the facility to transmit a carrier signal (NØN). (NØN is in effect the absence of modulation in the transmitter. This can be accomplished by inserting a carrier on 2182 kHz. H3E emission could also be used for this purpose.) Since many J3E transmitters already have carrier insertion capability, those transmitters are capable of transmitting a signal on which direction-finding is possible without requiring any modification.

4. Considerations with respect to the existing distress and safety system

4.1 *Compatibility of A3E, H3E and J3E classes of emission*

4.1.1 The Radio Regulations, modified by the World Administrative Radio Conference for Mobile Services (WARC-MOB-83) now provide that the J3E class of emission may be used by ships to transmit distress traffic with coast stations on 2182 kHz, where stations provide watches on J3E as well as A3E and H3E emissions. Class of emission J3E may now also be used for the exchange of distress traffic following the acknowledged reception of a distress call using digital selective calling techniques on 2187.5 kHz. Now that the J3E class of emission has been introduced for distress and safety purposes, the problem to be solved is the difficulty of ensuring a satisfactory and compatible system.

4.1.2 Tests have shown that where operator-attended watchkeeping is provided by coast stations, the identification and reception of type A3E and H3E signals in a J3E system is practicable. Communication for distress and safety between ships and coast stations is, in these circumstances, therefore achievable. The United States [CCIR, 1978-82] has reported implementation of single sideband (J3E) distress frequency watchkeeping by national ships in US waters and by US Coast Guard stations, effective 1 September 1978. The implementation of J3E has significantly improved the transmitting range as compared to H3E or A3E emissions. J3E receivers precisely tuned on the carrier frequency 2182 kHz reproduce intelligible audio signals when receiving A3E or H3E emissions with carrier frequencies deviating not more than 100 Hz from 2182 kHz.

Distress alarm signals can still be detected by an operator when their carrier frequencies deviate up to 300 Hz from the nominal frequency 2182 kHz.

In this regard it is significant to note that the Radio Regulations at present permit survival craft radio equipment to deviate 660 Hz from 2182 kHz.

When an operator at a US Coast Guard station recognizes that he is receiving other than J3E signals he will use the double sideband mode for further reception or transmission of signals.

4.1.3 However, existing distress and safety requirements call for the reception of distress signals from ships, survival craft stations and EPIRBs by ship stations as well as by coast stations.

To achieve this it may be necessary to design a watchkeeping receiver which automatically inserts into its demodulator a locally-generated carrier when a J3E signal is received and which would ensure that this local carrier was not present when A3E or H3E was being received.

4.1.4 The presence of an A3E or H3E signal in a J3E receiver would produce an inter-carrier beat frequency which could have a maximum frequency depending on the frequency tolerance of survival craft transmitters (300 ppm, or 655 Hz at 2182 kHz). Allowing a tolerance of ± 10 Hz on the carrier re-insertion frequency, the maximum anticipated inter-carrier beat frequency would be 665 Hz.

4.1.5 Beats would also occur between the re-inserted carrier and the sideband frequencies which, when demodulated, would produce tones within the audio passband of the receiver. These tones would obviously detract from the aural effectiveness of the two-tone alarm by an amount depending on the relative frequencies of the wanted and the unwanted tones. If the receiver was used in conjunction with a filtering device, the audio tone filters might reduce the likelihood that unwanted tones would be heard.

4.1.6 The problem cannot be completely solved except by arranging for the re-inserted carrier to be injected only in the presence of a J3E signal, or, to be absent during reception of an A3E or H3E signal. This arrangement would in any case be necessary for the satisfactory reception of voice transmissions.

4.1.7 Watchkeeping receivers designed to be compatible with both A3E and J3E emissions are technically feasible and it is of note that IMO (May 1981) requested CCIR to continue the study of a watchkeeping receiver capable of receiving single-sideband (J3E) and double sideband (A3E) emissions for possible use during a transitional period before the Future Global Maritime Distress and Safety System has been fully implemented.

4.1.8 In this respect the United Kingdom reported on tests in which the signal-to-noise ratios of two experimental receivers were evaluated in the A3E and J3E modes of reception to establish the levels at which the two-tone alarm signal was subjectively discernable and at which speech signals were intelligible.

A receiver whose RF imput passband was limited to that of the speech upper sideband, fed an envelope detector together with a 2182 kHz local oscillator signal. This gave satisfactory reception of both alarm and speech signals in the J3E mode with re-inserted carrier but with the detector efficiency reduced when compared with that possible from product detection. In the A3E mode, the re-inserted carrier failed to compensate fully for the power losses of RF filtering and removal of the lower sideband. While giving intelligible speech at high signal levels the required signal-to-noise ratio for the reception of A3E signals was unacceptable.

The receiver was modified to include a phase-locked loop circuit to detect the presence of the carrier of a received signal, and further tests were carried out. During these further tests, the recognition of the two-tone alarm signal was typically at −6 dB signal-to-noise ratio when A3E was being used and at −2 dB signal-to-noise ratio with J3E. No speech impairment occurred when A3E was in use and with J3E there was negligible impairment when the re-inserted carrier was within 100 Hz of the nominal frequency. The tests confirmed the viability of the phase-lock acquisition of a carrier with a frequency of up to at least 660 Hz from the nominal frequency. The tests also demonstrated that this technique could be used to re-insert a carrier when signals were detected by the product detector of a receiver but no carrier had simultaneously been acquired by the phase-locked loop circuit.

A second test receiver employing full double sideband RF bandwidth with subsequent manual signal switching to an appropriate detector was tested. For watchkeeping to detect two-tone alarm signals an envelope detector was preferred with local oscillator injection at 2185.5 kHz. The audio bandpass filtering was found to be inadequate to reject the 3.5 kHz intercarrier beat but this did not detract from reception of the alarm signals in either the A3E or the J3E modes of transmission. Further appropriate manual switching to give intelligible speech reception was indicated by the presence of an intercarrier beat frequency when switched first to the product detector for J3E reception.

Speech quality in both A3E and J3E modes was found to be satisfactory, however variation between the suppressed transmitter carrier frequency and the re-inserted carrier frequency modified the speech tone quality during J3E reception but speech intelligibility was not degraded when this frequency difference was within ± 150 Hz.

Any A3E transmissions received when the receiver was switched to the J3E mode caused an intercarrier beat frequency which however was at a lower detected level than the J3E signals and did not degrade J3E speech intelligibility.

It was considered that this test receiver was satisfactory for the reception of the two-tone alarm signal and distress speech messages in either the A3E or the J3E mode. Because of the RF bandwidth employed some of the inherent advantages of J3E over A3E emissions was forfeited. The requirement for manual switching to the appropriate mode of detection was also noted to be a potential operational disadvantage.

4.2 *Frequency accuracies and stabilities*

4.2.1 Before J3E can be introduced universally, some adjustments will be needed to the various frequency tolerances permitted by the Radio Regulations in distress equipment, particularly for satisfactory J3E operation with watchkeeping receivers using filters or a muting device.

4.2.2 The permitted long-term frequency tolerance on shipborne transmitters is ± 50 Hz for transmitters installed after 1 January, 1982. The permitted tolerance on the frequency of each of the tones of the two-tone alarm is ± 1.5% which, on the lower frequency tone of 1300 Hz, is ± 19.5 Hz (say ± 20 Hz). Typical requirements for the audio tone filter characteristic for watchkeeping receivers state that the response should be not more than 3 dB below the maximum response within 3% of the frequency of maximum response. This should occur within ± 1.5% of the tone frequency, and at least 20 dB below the maximum response at 15% of the frequency of maximum response.

4.2.3 If the frequency tolerance of ± 50 Hz for shipborne equipment was also applied to EPIRBs and survival craft equipment, the total system tolerance could be in the order of ± 120 Hz, or ± 9%, of the 1300 Hz tone. The effect of this in a J3E system would be that the tone frequencies at the receiver could vary between 1180 Hz and 1420 Hz, and between 2080 Hz and 2320 Hz respectively. However, the tone difference between the two notes should be reasonably constant at about 900 Hz and in most practical cases the variation of the tone frequencies would probably not exceed ± 50 Hz.

4.2.4 If watch for the two tones was kept aurally, it is unlikely that the variation in the tone frequencies would have any effect on the detection of the alarm signal because the distinctive "warble" would still be present. Similarly, if a muted watchkeeping receiver was used, the effect would probably be negligible because detection can be carried out by a combination of tone frequencies and the timing sequence. Provided the two tones are present and in the correct time relationship, such equipment should function correctly.

4.2.5 However, if a filtering device was used, the widening of the filters would increase the background noise possibly to the extent of defeating the purpose of the filters as a means of reducing the noise on a ship's bridge.

4.2.6 For satisfactory operation of a filtering device, or for the aural tones to be similar in note to the present system, considerably tighter tolerances will need to be applied to J3E equipment. In the present A3E and H3E modes the allowable tone frequency tolerance is applicable only to the tone generator in the transmitter. In the J3E mode the ± 20 Hz tolerance must be shared between the tone generator frequency, the transmitter carrier frequency and the receiver oscillator frequency, because in this mode the received tone frequency and amplitude depend also on the accuracy of the carrier re-inserted at the receiver.

4.2.7 Due to the frequencies involved, nearly all of the tolerance would have to be shared between the transmitter carrier frequency and the receiver oscillator, leaving a small tolerance of about ± 0.1 Hz on the frequency of the tone generator at 1300 Hz.

4.2.8 The division of the ± 20 Hz between different types of equipment will, in practice, probably be dictated by operational considerations and the current state-of-the-art of high stability oscillators. At present for equipment operating on the frequency 2182 kHz, the following tolerances, as shown in Table I, could be achieved at moderate cost:

TABLE I

Type of equipment	Temperature range	Frequency variation	
		with oven	without oven
Shipborne	0 to 40°C	±0.3 Hz	±10 Hz
Survival craft	− 25 to + 70°C	±0.3 Hz	±22 Hz

However, further study is required, in particular as regards the cost aspects.

4.2.9 Although it would be technically possible to provide survival craft equipment with temperature controlled ovens, this would introduce several problems, in particular the extra power which would be needed and the "warm up" arrangements. Under these circumstances, the necessary system tolerance of ± 20 Hz could not be met. However, if the shipborne equipment was temperature controlled, a worst system tolerance of ± 22.4 Hz could be achieved. This would be made up of ± 22 Hz for the survival craft equipment, ± 0.3 Hz for the shipborne equipment and ± 0.1 Hz on the frequency of the 1300 Hz tone generator. In view of crystal ageing etc., such requirements would require regular frequency verification of shipborne equipment. Other techniques providing stringent frequency tolerance in a hostile environment may be found to be applicable and study on this subject is necessary.

4.3 *Summary*

The advantages of J3E emissions are so significant that the use of this class of emission should be expanded for distress and safety purposes. To best accomplish this during a transitional period, it will be necessary to:

4.3.1 Introduce effective watch at coast stations for J3E distress signals to supplement existing watches for A3E and H3E ensuring that the existing distress service is in no way degraded.

4.3.2 Introduce the capability for maintaining watch for A3E, H3E and J3E distress signals on all ships.

4.3.3 Improve the frequency accuracy and stability of equipment required to be used in distress situations. In this connection, the ability of survival craft radio equipment and EPIRBs to achieve and maintain a frequency tolerance of around ± 20 Hz and for ship equipment a tolerance of ± 0.3 Hz should be studied. Manufacturing auto-alarm equipment compatible for J3E signals is feasible and introducing them could be helpful in ensuring compatibility between the various classes of emission until the FGMDSS completely replaces the existing system.

4.3.4 Assess in the present global philosophy of a 2182 kHz distress service the value of survival craft equipment and EPIRBs in relation to their dominant influence on the introduction of J3E emissions for distress and safety purposes.

4.3.5 Develop emergency equipment for J3E operation which is simple to operate and capable of reliable operation in widely variable environments after long periods of storage.

4.3.6 Take into account the IMO Recommendation on operational standards for radiotelephone watch receivers (Resolution No. A.383(X)) which requires equipment provided with a filtering unit to select the frequencies 1300 Hz and 2200 Hz. These frequencies are subject to a tolerance of ± 1.5%. In such cases the following tolerances are required:

- shipborne equipment ± 0.3 Hz
- survival craft equipment ± 22 Hz
- tone generators ± 0.1 Hz

4.3.7 In most practical cases, the frequency tolerance could be expanded with little degradation of automatic detectability because of passband margin and moderate attenuation near band edges of the tone filter in the watch receiver. Further experimental investigations of the acceptable frequency tolerance for the radiotelephone watch receivers are required.

4.3.8 Introducing J3E capability to supplement A3E or H3E transmitters used for distress purposes could help improve the effectiveness of the current distress system.

4.3.9 Until radio direction finders which can reliably home on J3E emissions become readily available, J3E transmitters on vessels which operate on 2182 kHz should also be capable of class of emission NØN.

5. Considerations with respect to the Future Global Maritime Distress and Safety System

5.1 *The use of the frequency 2182 kHz*

The frequency 2182 kHz will be required to be a dedicated international frequency for distress and safety traffic. It will be used for this purpose by ship, aircraft and survival craft stations.

As there will be no requirement for retaining the alerting function of the frequency 2182 kHz and thus the radiotelephone alarm and vital navigational warning signals will lose their present essential function, the introduction of J3E could be made considerably easier.

However, the use of the frequency 2182 kHz for homing purposes should be taken into account.

5.2 *Frequency accuracies and stabilities*

When the Future Global Maritime Distress and Safety System is fully implemented there will be no requirements for the distress frequency watchkeeping receiver as mentioned in § 4.3.6. Without this constraint, a frequency tolerance of 50 Hz would therefore seem to be suitable for a J3E operation on 2182 kHz.

6. Conclusions

6.1 The use of J3E emissions as an effective distress and safety function already exists. The schedule for the introduction and following expansion of J3E emissions for distress and safety purposes will depend upon the requirement for automatic alerting and the elimination of equipment not capable of J3E transmission and reception used in ships and survival craft, as well as the requirements for transition to the Future Global Maritime Distress and Safety System.

6.2 Full consideration should be given to all necessary measures to be taken during a time until A3E and H3E have been fully replaced by J3E to provide for the reception of J3E emissions, without degrading the reception of A3E and H3E emissions required for alerting, homing and communicating with ships and survival craft having radio equipment not compatible with J3E on the frequency 2182 kHz. New radio equipment capable of J3E transmission and reception should be fitted during this period.

6.3 Until radio direction finders which can reliably home on J3E emissions become readily available, J3E transmitters on vessels which operate on 2182 kHz should also be capable of class of emission NØN.

REFERENCES

IMO [1980a and b] Report to the Maritime Safety Committee. Doc. COM XXI/12; Doc. COM XXII/12. International Maritime Organization, London, UK.

CCIR Documents

[1978-82]: 8/154 (USA).

REPORT 748-1 *

IMPROVED USE OF THE HF RADIOTELEPHONE CHANNELS FOR COAST STATIONS IN THE BANDS ALLOCATED EXCLUSIVELY TO THE MARITIME MOBILE SERVICE

(Question 30/8)

(1978-1986)

1. Introduction

Under Question 30/8 it was decided that the CCIR should consider the technical and operational criteria to be adopted to enable the best utilization to be made of the HF radiotelephone channels.

In the Conclusions of the Interim Meeting of Study Group 8, [CCIR, 1974-78a], the results of Interim Working Party 8/2 (Geneva, 1974) are set out. Interim Working Party 8/2 was initially set up to give provisional advice to the IFRB concerning the allocation of HF radiotelephone channels and later to study Question 30/8.

Norway gave special attention to the operational aspects of Question 30/8 [CCIR, 1974-78b].

2. Results of Interim Working Party 8/2

The Interim Working Party agreed to base its work on existing CCIR Recommendations and Reports, in particular Recommendation 339 and Reports 252, 322, 340 and 525. In addition, use was made of Report 358.

Values of signal-to-interference protection ratios were derived in § 7.4 and 7.5 of the Report of the second meeting of the Interim Working Party to provide the IFRB with a basis for its work in relation to the allocation of radiotelephone channels in the maritime mobile service. The figures recommended were:

12 dB for just usable circuit quality and

21 dB for marginally commercial circuit quality.

In § 7.7 of the Report of the second meeting it was suggested that means of providing propagation forecasts for ships were desirable to enable them to select the optimum frequency band. Administrations were encouraged to provide such information to their ship and coast stations.

In § 7.8 figures for the amount of channel time per hour to be considered in connection with determining sharing possibilities were proposed.

3. Operational method for improving channel utilization used by Norway, Sweden and Denmark

Norway described a particular method used by Norway, Sweden and Denmark (as from 1 January 1978) to assist in improving the utilization of radiotelephone channels assigned to all three countries [CCIR, 1974-78b].

The method is based on sub-dividing the channels into exclusive and common channels, allocation of the exclusive channels being on a traffic load basis.

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* The Director, CCIR, is requested to bring this Report to the attention of the International Maritime Organization (IMO).