REPORT 501-5

DIGITAL SELECTIVE-CALLING SYSTEM FOR FUTURE OPERATIONAL REQUIREMENTS OF THE MARITIME MOBILE SERVICE

(Question 9/8)

(1970-1974-1978-1982-1986-1990)

1. Summary of work

1.1 *Operational and technical characteristics*

Studies on the subject of a digital selective-calling system to meet the future operational requirements of the maritime mobile service have been carried out since the 1966-69 study period.

The choice of the system is based on theoretical studies and on field tests carried out by the Administrations of the USA, USSR, Japan and the Netherlands [CCIR, 1974-78].

In order to expedite the study of the digital selective-calling system, Interim Working Party 8/3 was set up in 1975.

Recommendation 493-1 resulted mainly from the work carried out by Interim Working Party 8/3 during the study period 1974-78. It covered both the operational and technical characteristics in detail.

At the Final Meeting of Study Group 8, January 1978, Geneva, Recommendation 493-1 which was modified at the second meeting of Interim Working Party 8/3, held in Stockholm 1977, was considered in detail and adopted with minor amendments.

Further modifications to Recommendation 493-1 were made by Interim Working Party 8/8 (see § 1.2) when developing Recommendation 541-1 which were adopted by the Final Meeting of Study Group 8 (1981) and incorporated in Recommendation 493-2.

At the Interim Meeting of Study Group 8 (1984), revisions to Recommendation 493-2 were agreed, based on proposals from Interim Working Party 8/10 (which was set up primarily to coordinate trials of the DSC system – see § 1.3.1) which will further improve the performance of DSC, particularly with respect to decoding when errors are present.

At the Final Meeting of Study Group 8, November 1985, Geneva, Recommendation 493-2 was further modified, in particular with respect to phasing sequence detection and to define three classes of DSC equipment, and clarified, based on further proposals from Interim Working Party 8/10 and was adopted as Draft Recommendation 493-2(MOD F), which was approved by the XVIth Plenary Assembly as Recommendation 493-3.

1.2 *Operational procedures*

Initial guidance on operational procedures was considered in Recommendation 541 (Operational procedures) which was prepared at the second meeting of Interim Working Party 8/3 and considered at the Final Meeting of Study Group 8 (1978). It was recognized that these procedures were in general terms only and that the formulation of detailed procedures could not be carried out until practical experience had been gained in the actual operation of the digital selective-calling system.

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* The Director, CCIR, is invited to bring this Report, and in particular § 2.3, to the attention of the International Maritime Organization (IMO).

In accordance with CCIR Resolution 24-4 Interim Working Party 8/8 was set up in 1979 to hasten the development of operational procedures especially in relation to the requirements of a future global distress and safety system which is scheduled for consideration at the World Mobile Administrative Radio Conference in 1983.

Interim Working Party 8/8 subsequently amended Recommendation 541 to include detailed operational procedures for both distress and safety and other services and also considered the number of channels required for the DSC system. The resulting Recommendation 541-1 was adopted at the Final Meeting of Study Group 8 (1981).

Interim Working Party 8/8 also agreed that the radio frequency tolerance required for transmitters as well as receivers used in digital selective calling systems should be 10 Hz. (Existing equipment having a tolerance of 40 Hz for ship stations and 15 Hz for coast stations could be used in the initial implementation of the digital selective-calling system.)

During an initial period of implementation, a large number of ship transmitters might have greater frequency tolerances (e.g. 100 Hz) in accordance with Appendices 7 and 17 to the Radio Regulations.

To enable ship-borne transmitters with the above frequency tolerances to be used, Sweden in a contribution to Interim Working Party 8/8 proposed a receiver with three decoders connected in parallel with a suitable frequency offset and followed by a logical network to select the correct information. This could be one interim solution to facilitate the early introduction of digital selective calling. Laboratory tests in the Federal Republic of Germany confirmed the feasibility of the Swedish proposal. A frequency offset of ± 80 Hz would be required for a frequency tolerance of 100 Hz in the ship transmitter. This solution could be realized for acceptable extra complexity at the coast station.

France also presented a document concerning the 10 Hz tolerance which is recommended for DSC. This document discusses the additional cost to fulfil such a requirement and expresses concern on the maintenance and long-term tolerances of the equipment under these conditions.

At the Final Meeting of Study Group 8, Geneva, November, 1985, Recommendation 541-1 was modified as a result of the work of Interim Working Party 8/10 and adopted as Draft Recommendation 541-1(MOD F), which was approved by the XVIth Plenary Assembly as Recommendation 541-2.

1.3 *Trials*

1.3.1 *Coordinated trials*

In order to coordinate trials of the DSC system described in Recommendation 493-2 and test the procedures of Recommendation 541-1, Interim Working Party 8/10 was set up at the Final Meeting of Study Group 8 (1982).

1.3.1.1 *HF trials*

Interim Working Party 8/10 organized coordinated HF trials involving 9 stations which transmitted, during 16 days in October/November 1983, a total of approximately 13 000 DSC distress calls to 17 receiving stations. The location of the participating stations is given in Fig. 1.

The analysis of the trials' results was primarily aimed at testing the effectiveness of the DSC system for distress alerting.

Three types of call attempt were defined for this analysis:

- *single frequency call attempt:* a transmission sequence by one station within a short time period consisting of 5 individual transmissions of a message on the same frequency;
- *multi-frequency call attempt:* a transmission sequence by one station within a short time period consisting of one individual transmission of a message on each of four or five different frequencies;
- *composite call attempt:* a transmission sequence by one station within a given time period consisting of five transmissions of a message on each of four or five different frequencies.

This analysis included, for each call attempt, the probability of at least one call being received error-free by at least one of the receiving stations. The additional probability of receiving such a call with errors, but with no errors in either the self-identification or coordinates, was also calculated. An overall percentage for each type of call attempt (e.g. 4 MHz single frequency, 6 MHz single frequency, multi-frequency, composite) of all transmitting stations was calculated.

Table I gives the results of this analysis which is applicable to the use of DSC for alerting using distress calls.

A comparison of the results from the individual receiving stations with the CCIR propagation forecasts showed that, when the predicted field strength was $\geqslant 0$ dB(μV/m), approximately 60% of calls were received. This percentage gives an indication of the success of DSC for commercial calls, or calls transmitted to an individual station.

All calls were transmitted using a 2 s dot pattern. Eleven of the receiving stations used commercially available scanning receivers and the remaining 6 receiving stations used separate receivers on each frequency. The scanning receivers were set to scan the 5 HF frequencies within a 2 s period and the DSC equipment stopped the receiver scan on detection of the dot pattern.

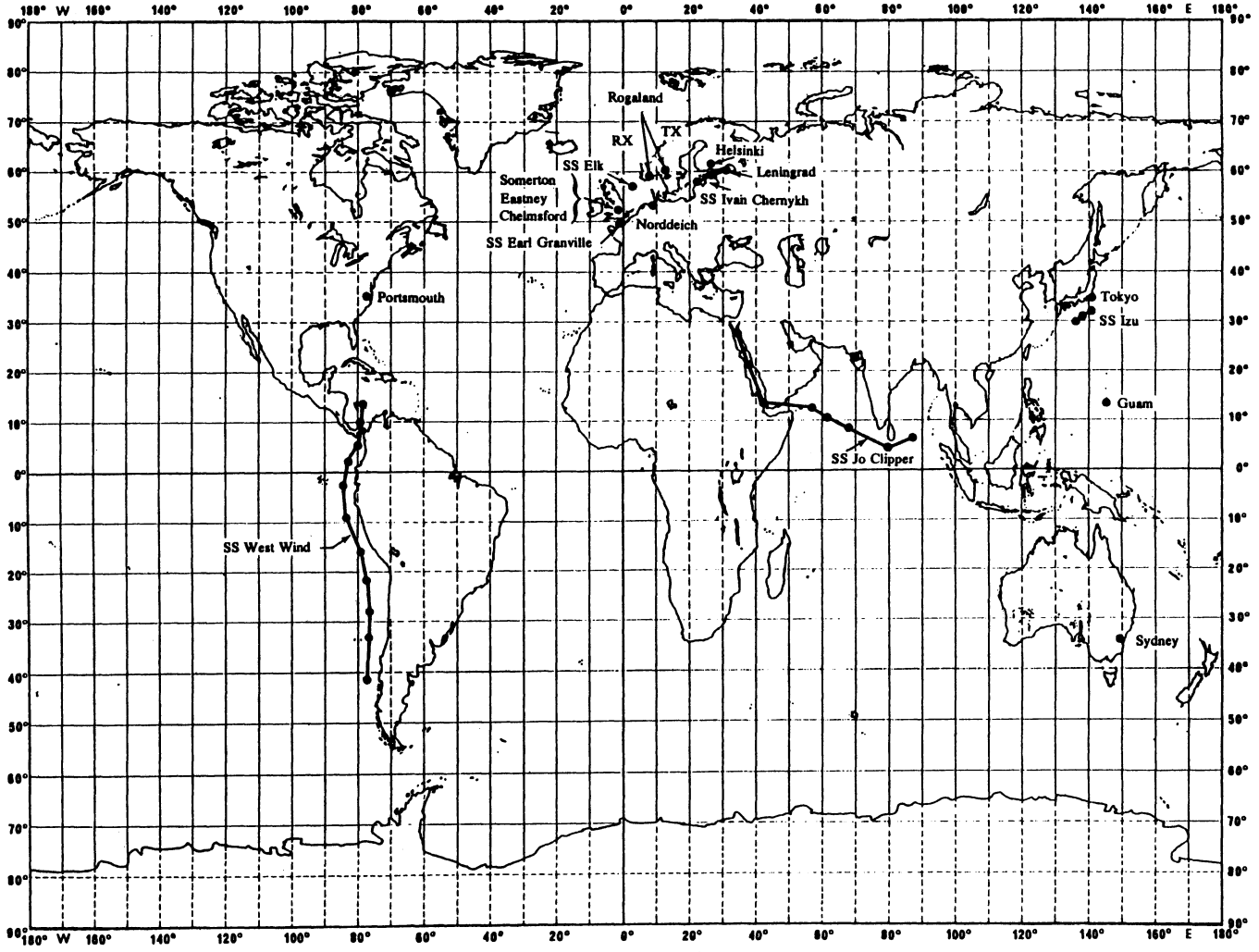


FIGURE 1 – *Location or stations participating in coordinated HF trials*

TABLE I – *DSC success probabilities during coordinated HF trials*

Transmitting station	Dates (1983)	Call attempts						
		Single frequency (MHz)					Multi-frequency	Composite
		4	6	8	13	17		
Rogaland	17/10	46/46	45+1/46	41+4/46	43+3/46	40+3/46	230/230	46/46
Portsmouth	18/10	0/0	9+3/24	11+1/24	20+1/24	21/24	94+9/120	24/24
Sydney	20/10	32/46	27+1/40	6/46	38/40	37/40	217+1/230	45/46
Tokyo	21/10	16/16	15+1/16	16/16	16/16	15+1/16	80/80	16/16
Guam	22/10	0/0	46/46	44/46	46/46	42+1/46	230/230	46/46
Portsmouth	24/10	0/0	21+1/31	27+1/31	31/31	23+2/30	155/155	31/31
Somerton	26/10	43/43	43/43	43/43	43/43	40+2/42	221/221	42/42
Tokyo	27/10	16/16	16/16	16/16	16/16	14/16	80/80	16/16
Guam	29/10	0/0	38/42	31/42	39/42	34+1/42	200/210	40/42
Somerton	31/10	45/45	45/45	46/46	46/46	46/46	228/228	43/43
Izu	1/11	16/16	15/16	15/16	16/16	15+1/16	80/80	16/16
Izu	4/11	16/16	16/16	16/16	16/16	16/16	80/80	16/16
Rogaland	5/11	46/46	46/46	45+1/46	42+3/46	38+7/46	230/230	46/46
Norddeich	7/11	46/46	46/46	43+1/44	41+2/44	38+3/44	229/229	46/46
Somerton	9/11	42/42	42/42	42/42	42/42	42/42	210/210	42/42
Ivan Chernykh	9/11	1/1	3/3	2/2	4/4	2+1/3	14/14	0/0
Totals		$\frac{365}{379}$	$\frac{473+7}{518}$	$\frac{444+8}{522}$	$\frac{499+9}{518}$	$\frac{464+22}{515}$	$\frac{2578+10}{2627}$	$\frac{515}{518}$
Percentage of calls received without errors		96.31	91.31	85.06	96.33	90.10	98.13	99.42
Additional percentage of calls received with errors but no errors in ID or coordinates		0	+1.35	+1.53	+1.74	+4.27	+0.38	0

Entries: Call attempts successful/call attempts transmitted. A + indicates additional number of calls received with errors, but no errors in ID or coordinates.

Note 1. – The United States of America stations (Portsmouth and Guam) did not transmit on 4 MHz.

Note 2. – In cases where an analysis of receivers logs casts doubt upon a given transmitter performance, the transmitter was, nevertheless, assumed to have performed correctly and the resulting low reception success rates were included in the above table. This table, therefore, represents a "worst case" analysis of the trial results. It is probable that these results under-estimate the performance of the participating receiving stations.

Note 3. – The combined logs of all receiving stations indicated that there was a problem with Sydney's scheduled transmissions on 8-11-1983. There were no propagation anomalies reported for that day, however, no station received calls on 4, 6, 8 or 13 MHz. Only Japan received a few calls on 17 MHz during the early morning hours (UTC). Therefore, the IWP disregarded the data on 8-11-1983.

The following comments apply to these results:

Several receiving stations suffered from severe interference, due in part to the fact that the frequencies used were in the coast station sub-bands. For a number of cases no radio propagation was possible between the participating stations. (Propagation forecasts had been made available by the CCIR Secretariat based on the latest version of Report 252.)

The following factors will improve DSC reliability:

- the use of the exclusive distress frequencies in accordance with the decisions of the WARC MOB-87 will improve the interference situation, as these frequencies are in the ship-station sub-bands;
- more receiving coast stations more evenly distributed around the world;
- participation of vessels fitted with GMDSS equipment;
- better receivers: e.g. adequate bandwidth in all cases (i.e. 300 Hz):
  - optimization of group delay characteristics;
  - fast AGC attack and release time, e.g. 10 ms;
- better modems: e.g. resistance to loss synchronization:
  - optimum pattern detection method;
  - independent mark and space detection;
  - use of slide-back demodulator;
  - no limiting in demodulator.

1.3.1.2 *MF trials*

During the period 18 March-4 April 1985, trials on an MF frequency were carried out in which 6 ships and 7 coast stations participated. These trials were conducted in the North Sea and the Baltic Sea areas. Appendix I gives details of the stations and the transmitting schedule.

The results were analyzed for the propagation conditions "Day" (mainly ground wave), "Night" (mainly sky wave) and "Dawn/Dusk" (ground and sky wave). The *approximate* times when these propagation conditions applied were:

Day	0600-1600 UTC
Night	1800-0500 UTC
Dawn/Dusk	0500-0600 and 1600-1800 UTC

The *actual* times used varied for each day of the trial, based on measured propagation conditions.

The results of the trials contain 6130 records of transmitted calls and 70 313 records of received calls. The following Tables II to VII show a concise presentation of the results achieved and Appendix II gives a tabular and a more detailed presentation of the results.

The Interim Working Party recognized that the propagation conditions and atmospheric noise levels experienced during these trials may not be applicable to sea areas in other parts of the world. However, the Interim Working Party was of the view that the results obtained were good and are indicative of the type or system performance which can be expected.

Table II shows a summary of data similar to that which would be obtained for a situation in which a vessel *transmits distress call attempts*, each consisting of 5 consecutive calls. These calls were transmitted to 7 coast stations and 5 ship stations. The percentage success figures given *indicate the probabilities of at least one call* (within the 5-call attempt) *being received error-free by at least one of the receiving stations.* The distance columns include only receive stations (ship and coast stations) beyond the indicated distance. The results show that even where the nearest receiving station was 300 nautical miles (NM) from the transmitting ship station, the 95% reliability required by IMO was exceeded, despite the limited number of participating stations.

Table III contains percentage success information of *distress call attempts* (each consisting of 5 consecutive calls) *in the direction ship-to-shore* for various distances between the ship and the receiving coast stations. These figures show the probabilities for alerting a particular coast station.

Table IV contains percentage success information of *distress call attempts* (each consisting of 5 consecutive calls) *in the direction shore-to-ship*, simulating distress alerting of ships by a coast station (e.g. shore-to-ship alerting/distress relay).

TABLE II – *Percentage success of error-free 5-call groups from a ship station to at least one of the receiving stations for categories of day-time and distance*

	Distance (NM)					
	> 7	> 100	> 150	> 200	> 250	> 300
Day	99.3	96.6	96.6	96.6	96.6	96.6
Night	100.0	100.0	100.0	100.0	100.0	99.6
Dawn/Dusk	100.0	100.0	100.0	100.0	100.0	100.0

TABLE III – *Percentage success of error-free 5-call groups over individual paths in ship-to-shore direction for categories of day-time and distance*

	Distance (NM)					
	0-100	101-150	151-200	201-250	251-300	> 300
Day	100.0	100.0	98.9	100.0	80.6	55.6
Night	81.5	82.7	90.8	97.4	94.7	82.9
Dawn/Dusk	100.0	96.6	100.0	92.0	86.2	70.2

TABLE IV – *Percentage success of error-free 5-call groups over individual paths in shore-to-ship direction for categories of day-time and distance*

	Distance (NM)					
	0-110	101-150	151-200	201-250	251-300	> 300
Day	83.1	95.9	100.0	73.3	85.2	41.8
Night	94.0	94.7	97.6	89.5	95.3	74.7
Dawn/Dusk	83.3	93.6	100.0	89.7	85.4	62.3

Table V contains percentage success information of *single calls in the direction shore-to-ship*, simulating acknowledgement of distress calls, and commercial calls in this direction.

Table VI contains the *same information as that in* Table IV but in the direction ship-to-shore, simulating commercial calls in this direction.

Table VII contains the *same information as that in Tables IV and V but in the direction ship-to-ship*, simulating commercial calls between ship stations.

TABLE V – *Percentage success of single error-free DSC calls over individual paths in shore-to-ship direction for categories of day-time and distance*

	Distance (NM)					
	0-100	101-150	151-200	201-250	251-300	> 300
Day	80.1	86.5	95.0	56.1	81.5	32.7
Night	88.9	74.7	80.9	69.5	82.8	57.9
Dawn/Dusk	77.9	77.9	86.7	76.4	88.6	50.9

TABLE VI – *Percentage success of single error-free DSC calls over individual paths in ship-to-shore direction for categories of day-time and distance*

	Distance (NM)					
	0-100	101-150	151-200	201-250	251-300	> 300
Day	95.4	95.6	94.4	87.9	71.1	40.8
Night	71.6	67.0	74.5	84.6	80.5	59.9
Dawn/Dusk	88.0	80.7	95.2	83.2	82.1	57.3

TABLE VII – *Percentage success of single error-free DSC calls over individual paths in ship-to-ship direction for categories of day-time and distance*

	Distance (NM)					
	0-100	101-150	151-200	201-250	251-300	> 300
Day	68.9	88.9	78.6	84.1	58.2	23.7
Night	71.6	83.3	73.7	51.0	45.2	63.2
Dawn/Dusk	74.7	98.2	87.6	59.6	93.7	46.0

1.3.1.3 *VHF trials*

VHF DSC field and laboratory trials conducted by the Nordic countries in mid-1985 produced results indicating that virtually 100% of calls were received with no errors up to distances exceeding that at which voice communications were satisfactory. Further details of those trials are given below.

Three coast stations and one ship station were used, equipped with newly developed equipment. The characteristics of the stations were as follows:

	Location	*Antenna height* (m)
Coast station Halden:	59°10'31" N 11°25'57" E	352
Coast station Vejby:	56°05'40" N 12°07'09" E	94
Coast station Karleby:	54°52'33" N 11°11'54" E	125
Ship Prinsesse Ragnhild:	sailing Oslo-Kiel	25

The sailing route and the locations of the coast stations are shown in Fig. 2. During the trials six passes through the limit of communication were logged. Of these, signal strength was also measured during four passages.

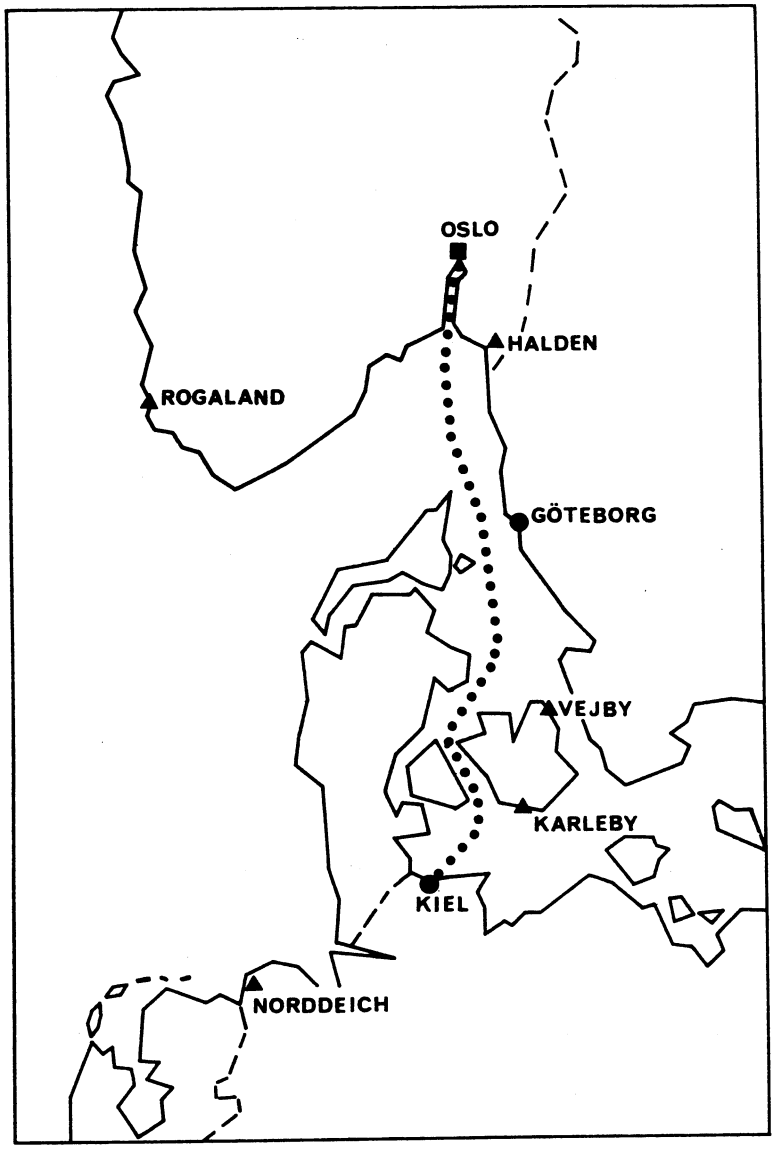


FIGURE 2 – *Sailing route*

One procedure for measurements prescribed that, at an agreed time, four single DSC calls were transmitted from a coast station to the ship on channel 70. After that, a voice signal was transmitted on another channel. The voice quality was subjectively assessed by the operator. At 10% the signal was barely readable; at 50% the signal was readable though noisy and 100% indicates a perfectly readable signal with very little noise.

A second procedure was that the coast station transmitted DSC calls to the ship station including the "acknowledgement request" and the ship responded with a DSC call to the coast station.

The results data of received DSC call success and voice quality versus distance are shown, for the three coast station paths, in Figs. 3, 4 and 5 and indicate that 100% error-free DSC reception was obtained up to distances exceeding the voice range.

Comparing the results with the calculated voice range, d, based on the IMO formula: $d = 2.5\ (\sqrt{h_1} + \sqrt{h_2})$, where h_1 and h_2 are the antenna heights in metres of the ship and coast station respectively and d is in nautical miles, gave the following results:

	Calculated (nautical miles)	Measured (nautical miles)
Halden	59.4	60
Vejby	36.7	47
Karleby	40.5	43

The results also showed that in all instances when the ship was in free waters and received a call, the acknowledgement was received at the coast station.

The Nordic trials therefore concluded that DSC reliably covered the calculated voice ranges.

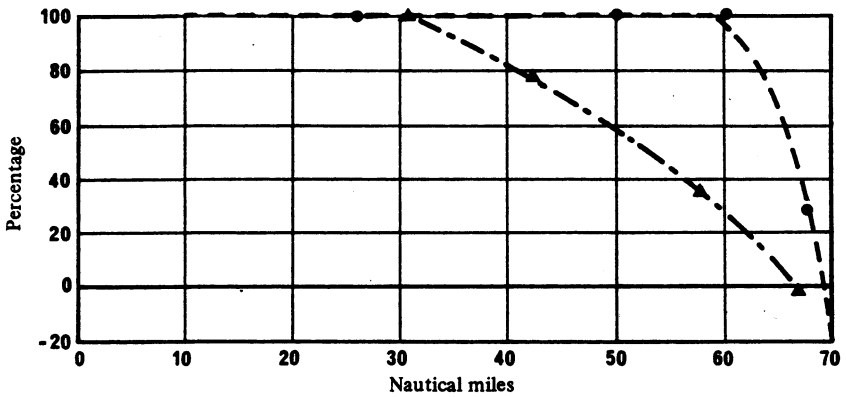
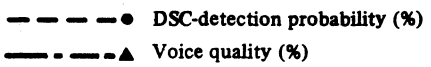


FIGURE 3 – *Measurements from Halden to "Prinsesse Ragnhild"*



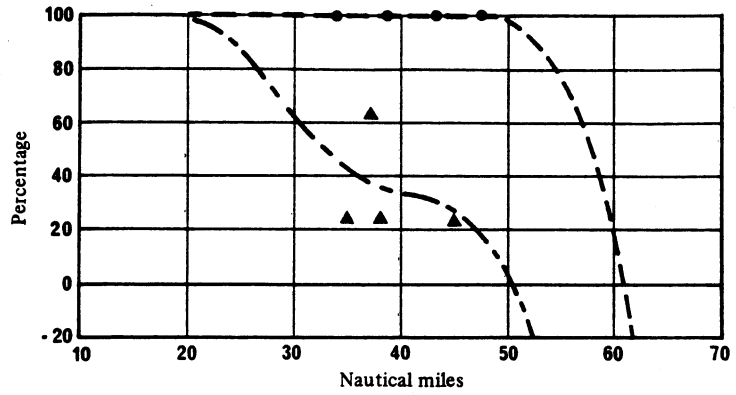
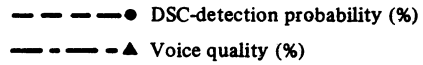


FIGURE 4 – *Measurements from Vejby to "Prinsesse Ragnhild"*



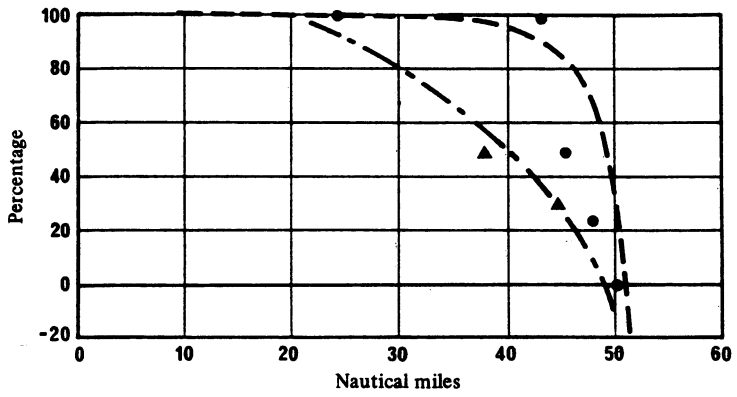
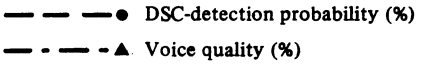


FIGURE 5 – *Measurements from Karleby to "Prinsesse Ragnhild"*



Laboratory measurements were made using the same VHF receiver as in the trials and a fading simulator, to investigate the possible influence of true Rayleigh fading as may be experienced in harbours and within archipelagos. Representative results are shown in Fig. 6. The results were not significantly different for speeds of the vessel between 6 and 22 knots.

Figure 6 is principally intended to show the effect of Rayleigh fading on the DSC call detection probability, and as such the signal-to-noise ratios indicated were measured with the maximum frequency deviation consistent with acceptable distortion. In practice the ratio in dB of maximum frequency deviation to the mean frequency deviation produced by normal speech is the same as the ratio in dB between peak envelope power and mean power for J3E. This ratio for J3E is indicated in Recommendation 326, Table I, as 10 dB.

The mean signal-to-noise ratio for speech transmission will therefore be 10 dB lower than that indicated in Fig. 6, i.e. 95% DSC call reception probability will be achieved with a signal-to-noise ratio of 8 dB.

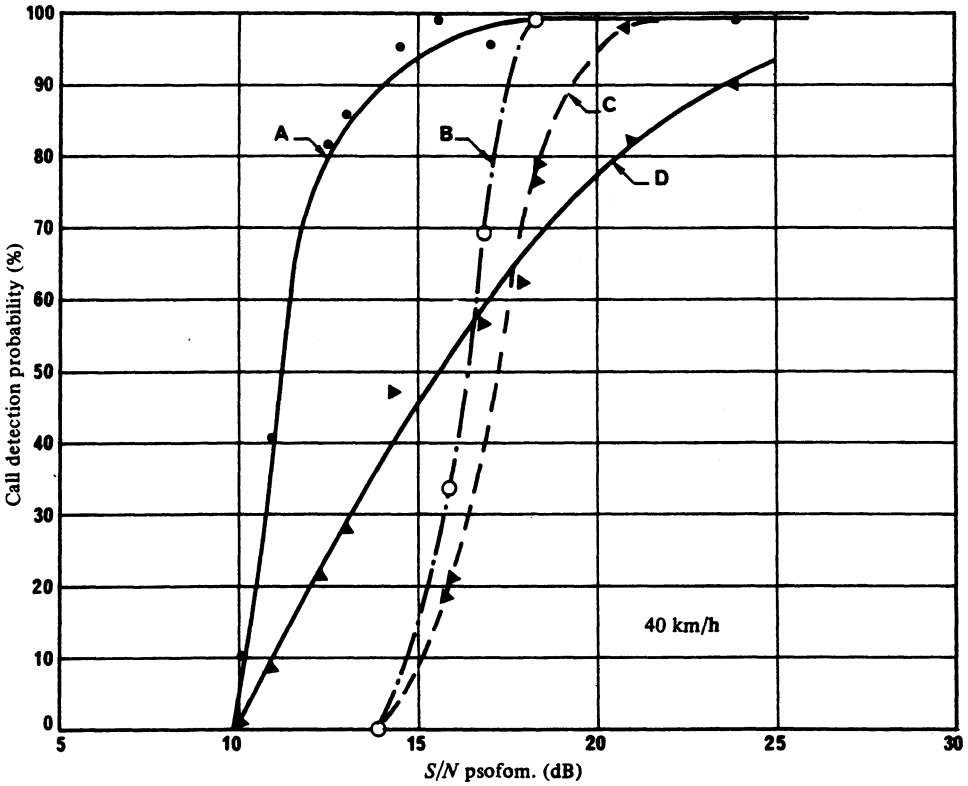


FIGURE 6 – *Laboratory measurements on VHF DSC equipment; call detection probability as a function of the signal-to-noise ratio*

Curves A: distress call attempt with Rayleigh fading
B: distress call attempt without fading
C: single call without fading
D: single call with Rayleigh fading

If the weighting effects of the psophometric filter used in the measurements are excluded, then a 95% DSC call reception probability would be achieved with a signal-to-noise ratio of 4 dB. Recommendation 339 indicates that "just usable" speech requires a signal-to-noise ratio of 6 dB.

It may be noted that when fading occurs, the detection probability of the distress call attempt is not decreased by as much as the signal-to-noise ratio for the speech transmission. This is because, the fading frequency is such that the probability is high that one of the five calls within a call attempt will occur when the signal is strong.

1.3.2 *Individual HF trials conducted by administrations*

Two Reports were presented to the Interim Meeting of Study Group 8 (1984) describing HF trials carried out by individual administrations.

1.3.2.1 *Trials by Japan*

Japan reported [CCIR, 1982-86a] on 3 HF trials conducted in November, 1982 and January, 1983 between a coast station in Japan and two ship stations. The first trial involved a ship sailing between Japan and Hawaii. A scanning receiver was used which stopped on the first frequency on which a call was detected. The IF bandwidth of the ship station receiver was 6 kHz but for the coast station was 1 kHz. The

second and third trials involved a ship at a distance of 750 km and 950 km from Japan respectively. The results were analyzed in terms of the optimum frequency and an IF bandwidth of 1 kHz was used in all cases.

Results of these three trials are presented in Table VIII. Calls which were not received error-free, due to interfering signals and noise at the receiving station, have been ignored in this table.

TABLE VIII

Trial No.	Receiving station	Percentage of error-free calls received
1	Ship	56.8% out of 280 calls
	Coast	73.8% out of 240 calls
2	Ship	98.8% out of 160 calls
	Coast	99.2% out of 120 calls
3	Ship	99.4% out of 320 calls
	Coast	97.1% out of 240 calls

1.3.2.2 *Trials by USSR*

The USSR reported [CCIR, 1982-86b] on two series of trials. The first trial involved HF tests at sea of DSC using mock-ups of equipment complying with Recommendation 493. The tests were carried out between two coast stations and two ship stations and there were, in many cases, poor radio propagation conditions. The probability of error-free DSC reception was found to be very largely dependent on the channel quality; however no call sequences with undetected errors were received.

A second trial involved tests designed to estimate the improvement obtained with multiple sequence transmissions using processing techniques. Tests were conducted on long propagation paths with call sequences equivalent to DSC transmitted using NBDP equipment in the B mode. The probabilities of error-free message reception for various character error rates for single sequence transmissions were then compared with those probabilities where three sequences were used. In this case a character was considered as having been received error-free if at least one of the three received sequences contained that character with no errors. Results from two series of trials are given in Table IX.

TABLE IX

Trial No.	Character error rate	Number of sequences transmitted	Error-free reception probabilities	
			One transmission	Three transmissions
1	< 0.03	46	0.54	0.98
	0.03-0.2	37	0.11	0.60
	> 0.2	4	0	0
2	< 0.03	31	0.55	1.00
	0.03-0.2	12	0.17	0.75
	> 0.2	1	0	0

1.3.3 *Further trials for HF commercial DSC*

Based on a proposal from Interim Working Party 8/10, the Final Meeting of Study Group 8, November 1985, Geneva, adopted guidelines for any future trials of HF commercial DSC (see Annex I). This Annex provides outline guidance to any administrations who wish to conduct further operational trials to assess the effectiveness of the operational procedures given in Recommendation 541, Annex II.

1.4 *Decoding methods*

The USSR presented, [CCIR, 1982-86c] a theoretical analysis of three possible decoding methods using repetitions of a DSC sequence based on Recommendation 493, Annex I, § 8.1. An analysis of different decoding algorithms based on a binomial error distribution is described.

The following conclusions were drawn from this analysis:

- the parameters indicated in § 8.1 of Annex I to Recommendation 493 may be achieved through repetition of the call sequence both with the given bit error ratio and for worse channel conditions;
- in order to obtain the values specified, algorithms using character or bit storage should be used with at least three repetitions;
- transmitting more than five times does not improve the performance for channel conditions corresponding to a bit error ratio probability of up to 10^{-1};
- the required probability indices are obtained over a wider range of channel conditions with the decoding algorithm which used bit storage;
- the introduction of repetition improves the conditions for reception with frequency scanning;
- in future DSC tests designed to assess the effect of the decoding method, it would be advisable to transmit the messages several times and evaluate the various decoding algorithms.

1.5 *Calling channels*

In Report 908, a preliminary estimate of the required number of calling channels for the future allocation of exclusive DSC channels was given based on the work of Interim Working Party 8/8. These estimates were, however, very tentative due to a lack of data.

At the Interim Meeting of Study Group 8, Report 908 was amended to include more realistic estimates for HF and MF based on the work of Interim Working Party 8/10 using traffic statistics obtained from 31 countries. At the Final Meeting of Study Group 8, November 1985, Geneva, Report 908 was further amended (in § 8) to include estimate for VHF channels and adopted as Report 908 (MOD F), which was approved by the XVIth Plenary Assembly as Report 908-1.

Although Report 908 primarily addresses the requirements for commercial calls (i.e. other than distress and safety), § 8 of that Report concludes that a single VHF channel is preferable for both distress and safety calls and commercial calls.

1.6 *3 kHz duplex separation for DSC channels in the band 435-526.5 kHz*

The Regional Administrative Radio Conference for the Planning of the MF Maritime Mobile and Aeronautical Radionavigation Services (Region 1), Geneva, 1985, invited the CCIR in Recommendation No. 6:

"To study the technical problems that may arise from the 3 kHz duplex separation in the digital selective-calling channels in the band 435-526.5 kHz."

Based on a contribution from the United Kingdom to Interim Working Party 8/10, the Final Meeting of Study Group 8, November 1985, Geneva, adopted Report 1028 which concludes that no technical problems will be encountered provided a minor amendment to Recommendation 541-1 (MOD I) is made. The substance of that amendment has been incorporated into Recommendation 541-2.

2. Future work

2.1 *Operational procedures*

The operational procedures described in Recommendation 541-1 do not specifically address the subject of ship-to-ship calling. These procedures need to be developed since it is envisaged that such operations using DSC will be employed in the maritime mobile service for commercial as well as distress and safety purposes. However, until specific procedures are developed, it is considered that the operating procedures detailed in Recommendation 541-2, Annex II, § 2 may be applicable to ship-to-ship operation.

2.2 *EPIRB signal*

The 1988 Amendments to the 1974 SOLAS Convention permits ships engaged on voyages exclusively in sea area A1 to carry, in lieu of a satellite EPIRB, an EPIRB which shall be capable of transmitting a distress alert using DSC on VHF (channel 70 of Appendix 18 of the Radio Regulations).

The characteristics and duty cycle of such an EPIRB should comply with the relevant provisions of Recommendation 493 and Recommendation 693.

REFERENCES

CCIR Documents

[1974-78]: 8/205 (Conclusions of the Interim Meeting of Study Group 8, 1976).

[1982-86]: **a.** 8/31 (Japan); **b.** 8/134 (USSR); **c.** 8/133 (USSR).

APPENDIX I

DETAILS OF STATIONS AND TRANSMITTING SCHEDULE DURING THE MF TRIALS

1. **Stations involved** (see also attached map, Fig. 7)

Country	Stations	Location/Route	Transmit/Receive
Germany (Federal Republic of)	Norddeich coast station	53°38′ N, 07°12′ E	TX and RX
Finland	Finnmerchant ship station	Helsinki-Hamina-Antwerp-Amsterdam	TX and RX
Netherlands	Scheveningen coast station	52°06′ N, 04°15′ E	TX and RX
Norway	Rogaland coast station	58°48′ N, 05°34′ E	TX and RX
	Prinsesse Ragnhild ship station	Oslo-Kiel	TX and RX
United Kingdom	Humber coast station	53°20′ N, 00°17′ E	TX and RX
	Thames coast station	51°20′ N, 00°20′ E	TX and RX
	Brae South (oil rig) coast station	58°41′ N, 01°17′ E	RX only
	Elk ship station	Middlesborough-Göteborg	TX and RX
	Norland ship station	Hull-Rotterdam	TX and RX
	BP Harrier ship station	Grangemouth-Great Yarmouth	RX only
USSR	Leningrad coast station	59°59′ N, 30°21′ E	TX and RX
	Alexander Prokofiev ship station	Leningrad-London	RX only

2. **Transmit schedule used**

Date (1985)	0405-1054 UTC	1205-1854 UTC	2005-0254 UTC
18 March	Thames	Norddeich	Norland
19	Rogaland	–	Humber
20	Humber	Rogaland	Thames
21	Leningrad	Rogaland	Norland
22	–	Elk	Norddeich
23	Thames	Ragnhild	Norland
24	Leningrad	Norddeich	–
25	Rogaland	–	Ragnhild
26	Finnmerchant	Humber	Leningrad
27	Leningrad	Finnmerchant	Norddeich
28	Thames	Humber	Ragnhild
29	Norddeich	Elk	Leningrad
30	Leningrad	Leningrad	Norland
31	–	Finnmerchant	–
1 April	Norddeich	Finnmerchant	Elk
2	Elk	Finnmerchant	Norland
3	Leningrad	Elk	Scheveningen
4	Norddeich	Scheveningen	Norland

Each of the transmit stations was scheduled to transmit 20 calls per hour (at 5, 6, 7, 8, 9, 20, 21, 22, 23, 24, 35, 36, 37, 38, 39, 50, 51, 52, 53 and 54 minutes past each hour) for the 7-hour periods indicated above. In practice not all scheduled transmissions were made in all cases.

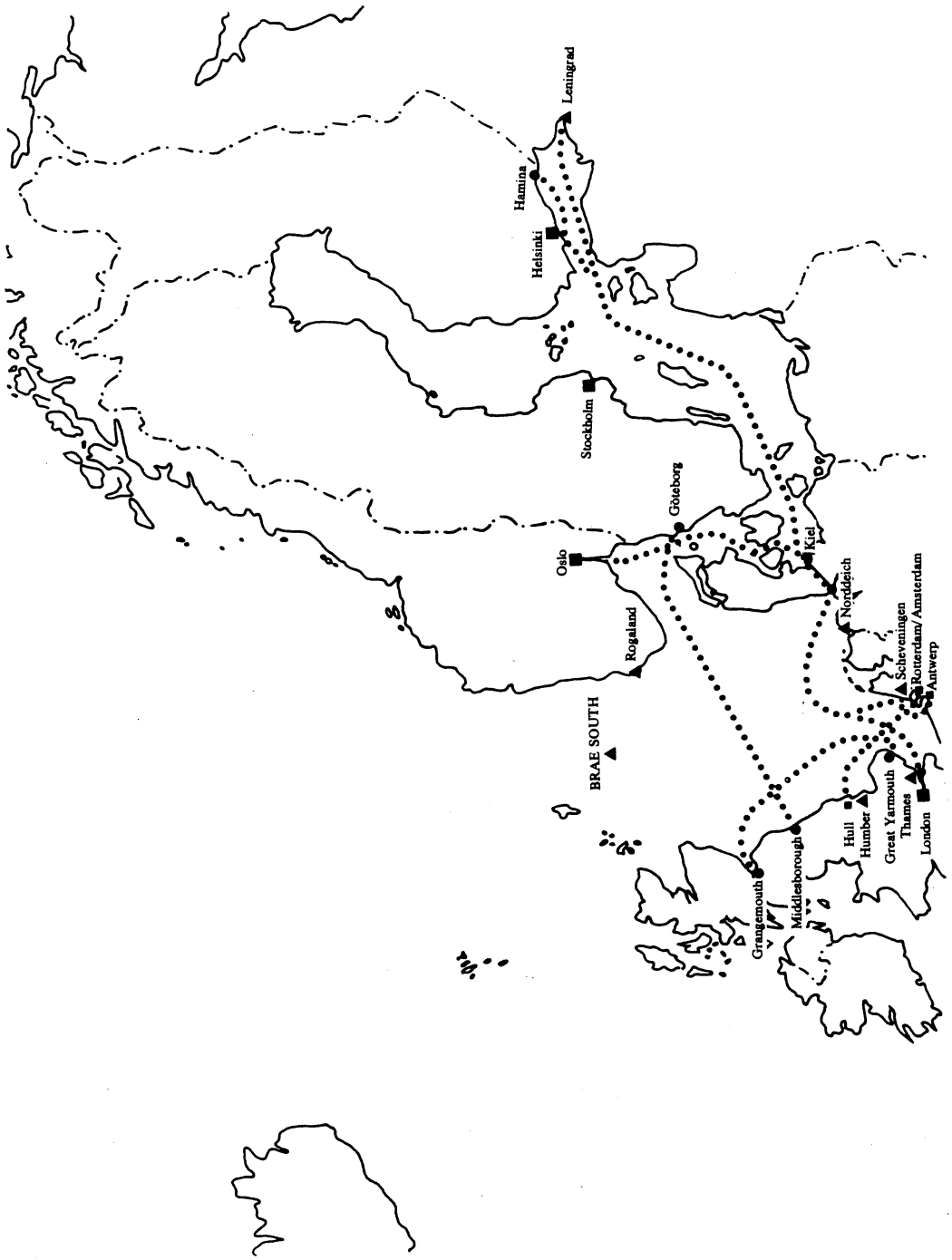


FIGURE 7 – *Stations involved in the MF trials*

ANNEX I

GUIDELINES FOR TRIALS FOR HF COMMERCIAL DSC

1. Objectives

In order to assess the effectiveness of the operational procedures of commercial HF DSC, trials should be carried out.

2. Parameters for trials

2.1 *Equipments and operational procedures*

All equipments in the trial should be in accordance with Recommendation 493 as approved by the XVIth Plenary Assembly in 1986 (see Note below).

Operational procedures should be in accordance with Recommendation 541 as approved by the XVIth Plenary Assembly in 1986.

Either real traffic or a test announcement/communication should be sent on the agreed working frequency(ies) by means of either radiotelephony or NBDP.

Typical coast station and ship transmit powers should be used.

Note: When coast stations need to use scanning receivers for trial purposes, a 200-bit dot pattern should be included in all calls.

TABLE X

Assigned coast station frequencies (kHz)	Assigned ship station frequencies (kHz)
4 357	4 187.5
6 506	6 281.5
8 718.5	8 375.5
13 100	12 562.0
17 232	16 750.5
22 595	22 248.0

2.2 *Transmission of calls*

During trials, transmissions should be made, if possible, at different times, and at the discretion of the stations concerned. There should be a minimum of 1 successful traffic/test communication per day from each ship station to each participating coast station, and each participating coast station to each ship station. If required, a precise transmission schedule may be defined by the participating countries.

2.3 *Format of calls*

The format of the DSC calling sequences to be used should be a selective call to an individual station, in accordance with Recommendation 493, Dubrovnik, 1986.

2.4 *Log-keeping*

2.4.1 *Transmitting log sheets* (see Table XI)

These should contain the following details:

- the date and time of the transmission of the calls;
- the position of the transmitting station (this applies to ship stations only);
- the acknowledgement of the call by the called station;
- the exchange of traffic on working frequencies or whether the called station was unable to comply.

2.4.2 *Receiving log sheets* (see Table XII)

These should contain the following details:

- the date and time of reception of a call;
- the position of the receiving station (this applies to ship station only);
- the acknowledgement of the call by the receiving station;
- the exchange of traffic on working frequencies.

2.4.3 *DSC analysis log sheets* (see Table XIII)

These should contain the following details:

- the date and time of the transmission of the initial DSC call;
- the name of the called station;
- the number of call repetitions;
- the time interval between transmission of the initial DSC call and receipt of the acknowledgement;
- the time interval between transmission of the initial DSC call and the start of exchange of traffic on working frequencies.

3. Analysis

The analysis should be done in the form indicated in Table XIII. Further analysis may also be appropriate.

4. Reporting of results

Result should be submitted by a single administration to Study Group 8.

TABLE XI – *DSC commercial trials transmitting log sheet*

Station: _____

Transmission		Position of transmitting station (only ship stations)	Acknowledgement received	Start of exchange of traffic on working frequencies	Unable to comply	Observations/ Remarks
Date	Time (UTC)		Time (UTC)	Time (UTC)		

TABLE XII – *DSC commercial trials receiving log sheet*

Station: _____

Reception of call		Position of receiving station (only ship stations)	Acknowledgement transmitted	Start of exchange of traffic on working frequencies	Observations/ Remarks
Date	Time (UTC)		Time (UTC)	Time (UTC)	

TABLE XIII – *DSC analysis*

Station: _____

Transmission		Station	No. of call repetitions	Time interval between transmission of initial DSC call and receipt of acknowledgement	Time interval between transmission of initial DSC call and start of exchange of traffic on working frequencies, if any
Date	Time (UTC)				

REPORT 908-1

CHANNEL REQUIREMENTS FOR A DIGITAL SELECTIVE-CALLING SYSTEM

(Question 9/8)

(1982-1986)

1. Introduction

A digital selective-calling (DSC) system could ultimately replace manual watchkeeping on ships and give automatic alerting facilities for all the communications of interest to the ship such as morse telegraphy, radiotelex, radiotelephony etc. Two types of channel will be required: international and national.

- *International channels.* These are used in the direction shore to ship only when a coast station wishes to call a ship but does not know which frequencies are being monitored by the ship. It is considered that these calls will be relatively few. International channels are available to all coast stations.
- *National channels.* These are used when a ship wishes to contact any coast station or a coast station wishes to contact a ship of its own nationality or a ship which it contacts regularly. National channels are associated with particular coast stations. Although the calls can be in both directions current calling patterns suggest that mainly the direction is ship to shore but this could change with an improved service. Experience with the INMARSAT system may give some guidance here.

No national DSC channels are as yet allocated, and the presently allocated numbers of international DSC channels may not be sufficient to support a fully developed DSC system, and new channels will have to be allocated. It is, therefore, important to endeavour to make a provisional forecast for the initial development of the DSC system.

This Report considers the number of calling channels that may ultimately be required for calls other than distress and safety. This information is of value to assist in preparation for the World Administrative Radio Conference for the Mobile Services in 1987.

2. Use of scanning receivers

The use of a scanning receiver leads to a non-zero probability that a call intended for the receiving station is lost due to the decoder being engaged on another channel, usually referred to as the scanning loss. Scanning loss is a function of the number of channels scanned by a single receiver and the loading of the DSC channels, but, as follows from the definition, is independent of the number of calls intended for the receiving station. As a general rule the use of scanning receivers is not to be encouraged as the scanning loss increases channel loading and thus has a cumulative effect. Nevertheless, it must be recognized that the use of scanning receivers may be a necessity on many ships for economic reasons.