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Estimation of usefulness of Digital Selective Calling (DSC) system in GMDSS

SUMMARY

In the paper results of the research on exploitation of the Digital Selective Calling (DSC) system are presented, carried out in real sea conditions during exploitation ships equipped with GMDSS devices. From the acquired data it results that the DSC system has been worldwide accepted although with some reticence and difficulties, and fulfils the presupposed functions in spite of the complicated operational procedures.

INTRODUCTION

In the Global Maritime Distress and Safety System (GMDSS) whose implementation period was completed in 1999 an important role was given to the entirely new subsystem, Digital Selective Calling (DSC), which permits, within the system and through terrestrial communication, to automatically create radiocommunication links, as well as establish communication of the distress, urgent, safety and routine type.

The distress system used at sea until quite recently made it possible to inform the ships being in the vicinity of an accident about the necessity of affording help. The newly implemented GMDSS radically changed the execution of alarming by giving ships the possibility of transmitting the alarm onto shore – to the Rescue Coordination Center by means of the DSC. This system makes it possible, without any use of satellites, to send distress signals from ships to land and back as well as between ships by using, at that end, the frequencies specially allotted out of theVHF, MF and HF sea bands. The frequencies are specified in Tab.1.

Tab.1. List of distress and emergency frequencies used in GMDSS

DSC Distress Frequencies		Associated voice frequencies	Associated data frequencies
VHF	156.525 MHz (Ch. 70)	156.8 MHz	
MF	2187.5 kHz	2182 kHz	2174.5 kHz
HF	4207.5 kHz	4125 kHz	4177.5 kHz
	6312 kHz	6215 kHz	6268 kHz
	8414.5 kHz	8291 kHz	8376.5 kHz
	12577 kHz	12290 kHz	12520 kHz
	16804 kHz	16420 kHz	16695 kHz

The basic technical and general characteristics of DSC system and its exploitation data was already presented in detail by the author in [5],[8]. Here only the most important issues will be reminded.

A synchronous system composed of ten-bit error-detecting code (according to [2]) is used to send a DSCS signal. It is based on the International Alphabet No 5 (ITA5 tab.1.2) composed of 2^7=128 sequences.

Fig.1 presents an example of 10-bit code sequence which constitutes the calling sequence divided into the information and control fields.

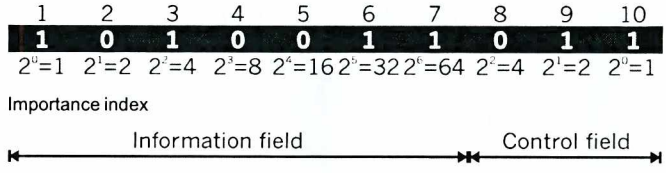

Fig.1.Example of 10-bit code sequence used for DSC system

As it results from Fig.1 in the information files the binary form of a definite symbol is listed where the sequence of importance index is reversed. The importance index subordinated to the first bit is 1, and to the seventh bit is 64. The detecting properties permitting to detect binary errors were created by giving the number of zeros of the information field in a binary form.

General format

The general format of a calling sequence is given in Tab.2. This format is called general as the calling sequence can take various kinds of calling depending on its destination.

Tab.2. General format of calling sequence

Dot pattern	Phasing sequence: bit synchronisation	Phasing sequence: block synchronisation	Format specifier	Address	Category	Self identification	Message 1	Message 2	Message 3	Message ...	End of sequence	Error-check character

Phasing sequence

The phasing sequence of calling provides :

- information to the receiver permitting to stop further searching; this receiver, according to the GMDSS characteristics, carries out radio watch on frequencies allocated to DSC
- information serving to precisely reproduce the position of particular bits and to unequivocally spot the position of code sequences forming the whole calling sequence.

Format specifier

The format specifier of calling sequence defines the form of the entire sequence, depending on the kind of calling. The symbol of the format specifier is transmitted twice in both DX (Direct) and RX (Repetition) positions. The symbols of the format specifier are :

- ✓ symbol 112 for a distress call
- ✓ symbol 116 for an „all ships" call
- ✓ symbol 114 for a selective call to a group of ships having common interest (e.g. belonging to a single shipowner or particular country)
- ✓ symbol 120 for a selective call to a particular individual station
- ✓ symbol 102 for a selective call to a group of ships in a particular geographic area.

Address

The address part of calling sequence contains information defining the addressee of a given sequence. For a selective call or group of ships, the numeric or alphanumeric address of the calling station is put into the address field. The call of the group of ships in a given geographic area is defined by coding geographic coordinates according to the Mercator projection. In the case of a distress call or all ships call the address is not given.

Category

The category information defines the degree of priority of the call sequence. For a distress call the priority is defined by the format specifier and the call sequence has no category information.

Self-identification

In the self-identification field a 9-digit identifier is transmitted, assigned to each station and coded as the address. It is used to identify the transmitting station.

Messages

The main task of a selective call is to transmit messages. The message in a call sequence consists of several elements and its form depends on the type of call. For distress calls the message concerning distress is contained in four elements :

- ★ message 1 describes the nature of distress endangering a ship
- ★ message 2 is the „distress coordinates" message indicating the location of the ship in distress, transmitted according to the Universal Time
- ★ message 3 indicates the time instant in which the above mentioned ship location occurs
- ★ message 4 is of a single character to indicate the type of communication (telephone or teleprinter) which is preferred by the station in distress.

End of sequence

The end of sequence character is transmitted three times in the DX position and once in RX position. It is of three unique characters corresponding to the symbols 117, 122 and 127 :

- ✦ symbol 117 if the call requires acknowledgement (RQ)
- ✦ symbol 122 if the sequence is an answer to the call which requires acknowledgement (BQ)
- ✦ symbol 127 for all other calls.

Error-check character

The error-check character is the final character transmitted and the sign of error check. It serves to date at the errors which are undeleted by the ten-unit error detecting code and the employed time diversity.

The seven information bits of the error-check character shall be equal to least significant bit of the modulo-2 sums of the corresponding bits of all information characters.

DESCRIPTION OF INVESTIGATIONS

The investigations in question were carried out on DSC system in real conditions of sea voyage of the Polish ship, m/v POLASIA (MMSI – 261431370) :

- ❖ from 19-06-1992 to 10-09-1992, i.e. during the first half-year of application of the GMDS system
- ❖ from 22-10-1992 to 10-01-1993, i.e. during the second half-year of application of the GMDS system.

Tab.3 contains position of the coast stations whose signals were received during investigations, and their basic data.

Tab.3. Basic parameters of the stations

Name of station	Country	Geographical position	Area coverage A1 [R1-nm]	Area coverage A2 [R2-nm]	MMSI
Blaavand Radio	Denmark	54°44'N 010°35'E	33	153	002192000
Skagen Radio	Denmark	57°44'N 010°35'E	29	148	002193000
Norddeich Radio	Germany	53°34'N 007°06'E	24	150	002114200
Elbe-Weser Radio	Germany	53°50'N 008°39'E	24	-	002114300
Kiel Radio	Germany	54°18'N 010°07'E	29	-	002114400
Rügen Radio	Germany	54°34'N 013°36'E	27	150	002114400
Netherlands Coast Radio	Netherlands	52°29'N 004°35'E	18-32	240	002442000
Torshavn Radio	Denmark	62°00'N 006°47'W	-	225	002311000
Göteborg Radio	Sweden	57°28'N 011°56'E	-	210	002651000
Witowo Radio	Poland	53°10'N 015°33'E	25	150	002640210

MMSI - Maritime Mobile Service Identification R - effective range radius of the station

The applied measuring apparatus was the ship radio-station equipped with GMDSS instruments of DEBEG firm, consisting inter alia of :

- VHF – DSC watch receiver 6310
- VHF – DSC controller 3817, and
- MF-HF DSC set with:
- SKANTII 28001 receiver
- DEBEG 3818 HF/HF DSC controller
- transreceiver SKANTII TRP-8401D.

INVESTIGATION RESULTS AND CONCLUSIONS

The measurements consisted of 374 measuring sessions. They were carried out :

- ⇨ in the coastal zone, i.e. A1 – to about 25 nautical miles with the help of signals out of VHF band (channel 70)
- ⇨ in the farther zone, i.e. A2 - to about 150 nautical miles with the help of 2187.5 kHz frequency
- ⇨ in the so-called range zones, i.e. A3 and A4 – with the help of short waves out of the following frequency bands: 4 MHz, 6 MHz, 8 MHz, 12 MHz and 16 MHz selected according to propagation conditions.

The analysis of the obtained results was carried out with taking into consideration the exploitation parameters essential for estimating the degree of usefulness of DSC system from the point of view of fulfilling its assumed functions within the GMDSS. The particular results are presented below :

In Fig.2 distributions are presented of the received DSC signal sequences in the particular frequency bands destined to send distress signals.

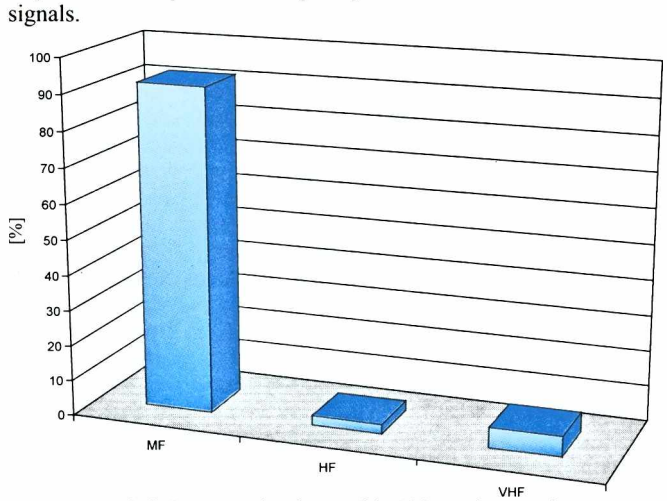

Fig.2. Percentage distribution of the DSC signals received within particular frequency bands

From Fig.2 it results that vast majority of callings (91,7%) was performed in MF bands, only 2,67% in HF band, and 5,61% in the VHF band (channel 70).

The DSC system was designed to establish radio-communication connection mainly to announce communications of the distress, urgent, safety and routine types.

The exploitation results of using this particular function of DSC system are shown in Fig.3 and 4. As it can be seen from the diagrams - with reference to short-wave bands – the DSC users exploited the DSC system to alarm about danger in 90% of callings.

This would confirm that the system's function of „alarming" on the open sea is fully useful and successfully replacing the out of date system based on MORSE telegraphy.

As far as the coastal zone is concerned 19% of all DSC callings were used to distress messaging in the VHF band, whereas only 6.7% of them with the use of MF range.

As regards the use of DSC system for urgent communication, the HF and VHF range was applied in 10% of all callings. The MF band was seldom used to that aim, i.e. in about 1,2% only. However, that frequency range was very often used to announce communication of the safety type, and as much as 84,2% of callings within the frequency range concerned that particular function. A similar situation occurs in the VHF range where the corresponding result amounts to 71,4%.

However the short waves were not used at all for that type of communication and routine communication as well. This makes it possible to conclude that the short-wave application of DSC system is considered by users mainly as the system for alarming in open seas, and not for other types of communication such as : notice of safety or routine one.

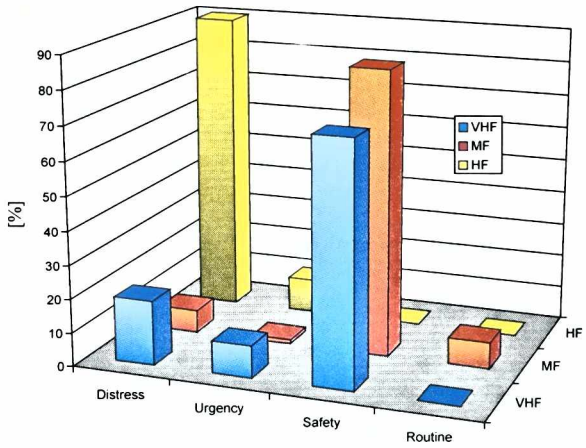

Fig.3. Percentage distribution of the DSC callings received in the particular bands in function of the communication categories

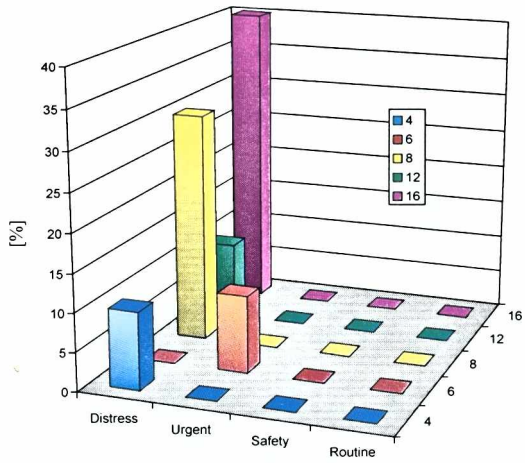

Fig.4. Percentage distribution of the DSC callings received within the sub-bands of short-wave range in relation to the communication type

Fig.4. shows the distribution of DSC callings in sub-bands of the HF range in relation to the communication type. It reveals that 16 MHz band was most frequently used to alarm as up to 40% of DSC callings were performed on that frequency and 30% on 8 MHz band. The remaining sub-ranges destined for alarming were rarely used.

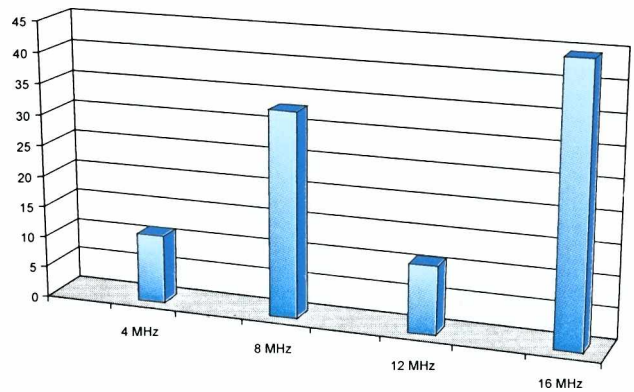

Fig.5.Percentage distribution of DSC distress callings in HF bands

In general the HF range was found mainly employed by users to perform distress communication, whereas other types of communication were occasionally or never realized within that range.

It can by seen from Fig.5 that the DSC distress signals were sent first of all by using 16 MHz frequency band. This proves that in a dangerous situation and far zone at sea this particular frequency gives the

best chance to correctly deliver distress information to a coast station. That frequency was used in up to 44,4% of distress callings, whereas 33% of distress callings were sent on 8 MHz frequency band. Moreover in the procedures of sending distress signals that frequency is indicated as the first which should be used for that purpose.

4 MHz and 12 MHz frequency band were used less often (about 11%) whereas 6 MHz band frequency was not used at all.

Appraised by Józef Modelski, Prof.,D.Sc.

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Conference

Scientific seminar on utility foundations

The last-in-the-year scientific meeting of the Regional Group of the Utility Foundations Section (SPE) , Mechanical Engineering Committee (KBM), Polish Academy of Sciences (PAN), devoted to :

„Selected problems of machine building and operation"

was held on 30 November 1999. The Seminar was hosted by the Faculty of Ocean and Ship Technology, Technical University of Gdańsk. Opening the meeting Prof. Krzysztof Rosochowicz, the Dean of the Faculty, acquainted the participants with current organization of the Faculty, its didactic activity, assumed lines of its further development, current scientific research topics, relations with shipbuilding industry and contacts with foreign scientific centres.

In the scientific part of the Seminar the following papers were presented :

- „Problems of designing the power systems for dredgers" by Damian Bocheński
- „A numerical testing method of stability of sliding radial seal" by Czesław Dymarski
- „An investigation stand for determining pressure distribution on the over-shroud seal of the turbine stage" by Krzysztof Kosowski and Marian Piwowarski
- „Analysis of the loading exerted during trailing processes onto ship board machines and propulsion devices, by applying Lagrange equations" - by Józef Krępa
- „Safety and relability analysis of the ship power systems by means of PABSO software" – by Piotr Nowak
- „A gauge for temperature measurement within compressible gas non-stationary flow" - by Robert Werner.

The papers met with high interest of the audience, manifested by vivid discussion. Within the Seminar's confines its participants had the occasion to be acquainted with research stands of the Machine Laboratory of the Faculty.

Conference

MECHANIKA '99

Since 1995 the mechanical faculties of the technical universities of northern Poland (in Gdańsk, Gdynia, Szczecin, Koszalin, Bydgoszcz, Olsztyn, Elbląg and Białystok) and the Fluid Fow Machinery Institute of Polish Academy of Science,Gdańsk, have organized the conferences to promote their scientific research and didactic accomplishments.

They are held every second year. On 25 and 26 November 1999 the conference under the same traditional heading :

MECHANIKA '99 – THEORY AND PRACTICE

was organized and hosted by the Mechanical Faculty, Technical University of Gdańsk, whose acting dean, Prof. Włodzimierz Walczak took over the function from Prof. Andrzej Balawander.

The MECHANIKA conferences are one of the forms of arranging contacts between the universities and economic and industrial circles. The last conference introduced some new proposals, simultaneously maintaining the elements which earlier proved effective.

General presentation of the particular mechanical faculties, presentation of the proposals of application of engineering processes and designs as well as testing, measurement and computation methods, belong to the permanent elements of the conferences offerred by both individual authors and research teams. The so called „Forum of Youth" is also deemed the conference's permanent element where young scientific workers, postgraduate and just graduated students from the faculties in question can present their rewarded diploma theses, postgraduate research works and just defended doctor's theses.

However presentation of the applied science papers was a novel element of the last conference.

The conference proceedings were published in two volumes.

I Volume contains :

- presentation of the particular Mechanical Faculties, Fluid Flow Machinery Institute of Polish Academy of Science, Faculty of Ocean and Ship Technology of Technical University of Gdańsk, Faculty of Maritime Technology of Technical University of Szczecin, and Polytechnic Institute of the State Higher Professional School in Elbląg
- 96 application proposals, among which 37 were offered by the Mechanical Faculty, Technical University of Gdańsk, and 19 - by the Mechanical Faculty, Technical University of Koszalin.

II Volume contains :

- 42 papers presented at the „Forum of Seniors"
- 23 papers presented at the „Forum of Youth"

Moreover, during the „Forum of Seniors" 5 papers were presented, which are not contained in the published proceedings.

It should be emphasized that especially scientists of the Technical University of Gdańsk and Technical Faculty of Warmian – Mazurian University in Olsztyn very actively took part in the „Forum of Seniors" (by presenting 17 papers of each university), and in the „Forum of Youth" – (10 papers of Technical University of Gdańsk).

The conference participants had an opportunity to visit Gdańsk Oil Refinery, Refrigeration and Air Conditioning Equipment Works, „Klimor", Gdynia, and the biggest-in-Poland manufacturer of sliding bearings, „Federal-Mogul Bimet", Gdańsk.