MARITIME RADIATION PROTECTION AND SEAMEN'S SAFETY

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Abstract

Maritime laws rarely address radiation emergency medical management. According to the *International Convention for Safety of Life at Sea – SOLAS*, this area is not defined.

Various countries have various government bodies in charge of maritime affairs. They adopt or implement into their legal system various laws and ordinances in conformity with international regulations and corresponding recommendations.

This paper analyses training programmes for radiation emergency procedures and medical assistance on board ships.

Deficiencies are presented and further development is proposed, in order to improve the safety of human life on board ships with regard to protection, first aid and medical care.

Keywords
radiation, protection, safety

1 INTRODUCTION

The term *radiation* describes any process in which energy emitted by one body travels through a medium or through space, ultimately to be absorbed by another body. Some radiations can be hazardous [4].

Radiation on board ships can be divided with respect to the source:

- nuclear,
- electromagnetic, and
- acoustic [1].

Nuclear radiation occurs in nuclear weapons, nuclear reactors and radioactive substances. The risk of potential terrorist attacks is unfortunately a reality. If such an incident were to take place, people in the vicinity could be exposed to radiation or contaminated with radioactive materials. The exposed people could seek treatment for radiation exposure or reassurance that their health has not been affected. Most vessels and ports are not prepared to deal with a large number of people who could seek medical assistance in the event of radioactive contamination and possible exposure to radiation (Table 1) [7].

Possible scenarios of a nuclear attack could include:

- nuclear power plant incident,
- hidden source,
- "dirty bomb",
- improvised nuclear device,
- nuclear weapon [7].

Port scanning equipment often operates by means of radiation, e.g. the *Integrated Container Information System - ICIS,* the Vehicle and Cargo Inspection – *VACIS,* etc.[2]. Training in handling radioactive cargoes includes treatment of cargo, freight accommodation on board etc., but does not include first aid in case of radiation, protection from radiation, emergency radiation procedures, etc.

Table 1: Predicted distribution of injuries from nuclear explosion

Type of injuries	***Percentage***
Single injuries	*30-40%*
Ionizing radiation (including fallout)	*15-20%*
Burns	*15-20%*
Wounds	*Up to 20%*

Control, Salt Lake City, Utah, March 1998, available at: (Source: Bill Craig, *Radiation Detection Equipment*, Utah Division of Radiation www.cdphe.state.co.us/epr/Public/WIPP/equipselect.pdf)

Electromagnetic radiation (i.e. radio waves, infrared light, visible light, ultraviolet light, and X-rays) can also be ionizing radiation. In addition, marine radar, high voltage equipment, communication, locating and other ship equipment often operate by means of electromagnetic radiation. Radiation from such sources does not have nearly the power of a nuclear event, but it nevertheless affects the health of people who are in the immediate vicinity. Ultraviolet (UV) light is electromagnetic radiation with a wavelength shorter than that of visible light, but longer than X-rays, ranging from 10 nm to 400 nm, with energy ranging from 3 eV to 124 eV. It is called *ultraviolet* because the spectrum consists of electromagnetic waves with frequencies higher than those that humans can identify as the violet colour. UV light is found in sunlight and is emitted by electric arcs and specialized lights such as black lights. As an ionizing radiation, it can cause chemical reactions and make many fluorescent substances to glow. Most people are aware of the effects of UV through the painful condition of sunburn. Risk of solar radiation has increased due to a hole created in the ozone layer. Ultraviolet (UV) photons harm the DNA molecules of living organisms in different ways. In a common damage event, adjacent bases

bond with each other, instead of across the "ladder". This makes a bulge, and the distorted DNA molecule does not function properly (Figure 1) [5].

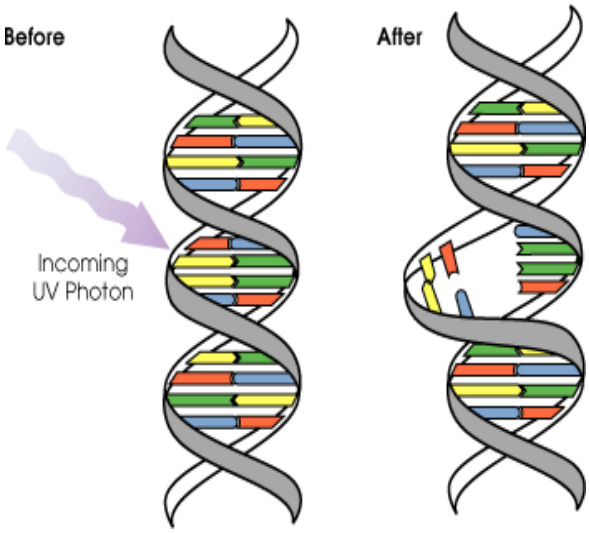

Figure 1: DNA UV mutation
(Source: www.wikipedia.org)

It has been ascertained that the machinery radiation noise induced by a ship engine is one of the most important ship radiation sources. Sound produced by some devices may have frequencies that are detrimental to human body. [8]

The recommendations of the SOLAS Convention Resolution A.748 (18) from 1993 and International Maritime Dangerous Goods Code (IMDG) regulate transport of radioactive goods such as irradiated nuclear fuels (for example plutonium, thorium, uranium, plutonium isotopes etc.)

However, none of the conventions or codes is related to protection from radiation, first aid, emergency procedures, electromagnetic radiation equipment, work in an area containing radioactive materials, etc.

2 REGULATIONS, PROTECTION AND EDUCATION

Relevant ordinances, in compliance with recommendations of the IMO and other organisations, enforced by national administrations, regulate seamen's obligations regarding:

- First medical aid,
- Medical care,
- International Ship and Port Security Code (ISPS), and
- IMDG Code.

The Certificate of competence for giving first-aid treatment pursuant to the Standards for Training and Watchkeeping Certificate - STCW VI/4 is issued to a seaman who has completed a special course and passed the exam. In order to acquire the competence for giving first-aid treatment it is necessary to master the programme consisting of various topics, each including a specified number of lectures and practice (Table 2).

Table 2: First aid programme for seafarers

Topic		*Number of hours*	
		Lectures	***Practice***
1.	*Immediate actions*	*1.0*	*1.0*
2.	*Instruments for first aid*	*0.25*	*0.5*
3.	*Body structure and functions*	*2.0*	*0.5*
4.	*Risk of poisoning on a ship*	*1.0*	*0.5*
5.	*Examining a patient*	*1.0*	*0.5*
6.	*Spine injuries*	*1.0*	*1.0*
7.	*Burns, steam injuries, consequences of excessive cold and heat*	*1.0*	*1.0*
8.	*Fractures and sprains, muscle injuries*	*1.0*	*1.0*
9.	*Medical care of the rescued, including distress, hypothermia and freezing*	*1.0*	
10.	*Medical advice through radio*	*1.0*	
11.	*Pharmacology*	*0.5*	*0.5*
12.	*Sterilisation*	*0.5*	*1.0*
13.	*Heart attack, drowning and suffocation*	*1.0*	*1.25*
TOTAL		***12.25***	***8.75***
TOTAL (LECTURES + PRACTICE)		***21.0***	

(Source: Kasum, J., Vidan, P., Baljak, K., *Maritime Medical Protection and Seaman's Safety*, The International Emergency Management Society Conference – TIEMS, Prague, 2008)

During the course for acquiring the *Competence of giving first-aid treatment*, the following equipment is used:

- ship's dispensary without medication,
- stretchers,
- resuscitator,
- dummy for practising resuscitating procedure,
- bandages,
- splint, and
- immobilisation devices.

The *Certificate of competence for giving medical care on board the ship (STCW VI/4)* is issued to a seaman who has completed a special course and passed the exam. In order to acquire competence for giving medical care on board ships it

is necessary to master the programme consisting of various topics, each including a specified number of lectures and practice (Table 3).

Table 3: Programme for medical care on board the ship

	Topic	Hours	
		Lectures	Practice
1.	First aid	3.0	2.0
2.	Care of wrecked persons	4.0	3.0
3.	Nursing care	1.5	0.5
4.	Diseases	3.0	1.0
5.	Alcohol and drug abuse	2.0	0
6.	Dental care	1.0	1.0
7.	Gynaecology, obstetrics, pregnancy and delivery	2.0	0
8.	Medical care of rescued people, including disaster, hypothermia and exposure to cold	2.0	0
9.	Death at sea	1.0	0
10.	Help given by a third party	2.0	0
11.	Control of the ship	1.0	1.0
12.	Prevention of diseases	2.0	0
13.	Regulations and keeping records	2.0	0
14.	Medicines and medical equipment	1.0	1.0
15.	Surgery equipment, instruments and accessories	2.0	1.0
TOTAL		**29.5**	**10.5**
TOTAL (LECTURES + PRACTICE9		**40.0**	

(Source: Kasum, J., Vidan, P., Baljak, K., *Maritime Medical Protection and Seaman's Safety*, The International Emergency Management Society Conference – TIEMS, Prague, 2008)

During the course for acquiring the *Certificate on competence for giving medical care on the ship* the following equipment is used:

- ship's dispensary without medication,
- stretchers,
- resuscitator,
- dummy for practising resuscitating procedure,
- bandages,
- splints,
- immobilisation devices,
- laboratory equipment for clinical testing,
- equipment for eye injuries treatment, and
- reference video material.

Table 4: Programme for ISPS Code on board ships

	Topic	Hours	
		Lectures	Practice
1.	Introduction	1,5	0
2.	Security policy in marine environment	1	0
3.	Responsibility for security	1.5	0
4.	Ship security assessment	1,5	0
5.	Safety equipment	2.0	0
6.	Ship Security plan	1.0	0
7.	Threat identification and detection methods	1,5	1
8.	Safety procedures on board	1.0	0
9.	Readiness in the event of an emergency training and exercises	1.0	0
10.	Notes on safety	1.0	0
11.	Security training	1,0	0
TOTAL		**14**	**1**
TOTAL (LECTURES + PRACTICE)		**15**	

(Source: Kasum, J., Vidan, P., Baljak, K., *Maritime Medical Protection and Seaman's Safety*, The International Emergency Management Society Conference – TIEMS, Prague, 2008)

The *Certificate of competence for the ship officer responsible for ship security (STCW VI/4)* is issued to an officer who has completed a special course and passed the exam which is in accordance with Table 4. During the course for acquiring the ISPS certificate, seafarers are trained to identify and assess risks (Table 4). In addition, they learn different ways to search the ship and to manage people involved in searching the ship in an emergency. The ISPS training enables the seafarers to deal with potential terrorist events, but the seafarers are not familiarised with the procedures in case of radiation hazards, protection, first aid, etc. Although the ISPS training provides for the use of devices that operate by means of search-based X-ray radiation, protection measures and measurement of radiation are not described.

Table 5: Programme for Certificate of competence in dangerous goods handling on board ships

Topic		Hours	
		Lectures	**Practice**
1.	Introduction, goal and purpose of the course	0,75	
2.	Review of the previous development and general interpretation of the Convention	0,5	
3.	Conventions	0,5	
4.	IMO and hazardous substances	0,5	
5.	IMDG regulations	1,25	1,5
6.	Rating: physical and chemical properties	1,5	
7.	Rating: UN system as applied by IMO	1	
8.	Rating: IMDG class	2,5	
9.	Packaging and requirements for tanks	1	2,5
10.	Construction and testing of packaging, IBCs and portable tanks	0,5	
11.	Methods of delivery	1,5	
12.	Limitation amount		
13.	Transportation Amendment	6	1,5
14.	IMDG regulations	1,5	1,0
15.	Safe transportation and storage of dangerous goods in ports	1,5	
16.	Changes in the future	0,5	0,0
TOTAL		**21,5**	**6,5**
TOTAL (LECTURES + PRACTICE)		**28**	

(Source: http://www.imdge-learning.com/)

The *Certificate of competence in dangerous goods handling (STCW VI/4)* is issued to a seaman who has passed the course and the test program from the Table 5. The course includes lectures and exercises.

The training program for acquiring the *Certificate of competence in dangerous goods handling* include handling dangerous cargo following guidelines and recommendations of the *International Convention for the Prevention of Pollution From Ships* – MARPOL, IMDG and SOLAS. Its primary intention is to describe safe loading and handling of dangerous goods, their characteristics and arrangement on board the ship.

It is obvious that during their training for giving first-aid treatment and medical care, and for acquiring ISPS procedures and IMDG Code, seamen are trained for a relatively wide range of competence in the field of safety, security and medical treatment. However, no certificate of competency requires seamen to master procedures in the event of radiation. Consequently, seamen are not familiar with the methods of detecting radiation on board, handling radioactive material, protecting people from radiation and providing first aid and medical care to people injured by radiation.

CONCLUSIONS

In order to increase the level of protection of seamen against radiation it is proposed to institute a new training programme on the safety and security, as well as first aid and medical care, which would include radiation protection, first aid and medical care of irradiated patients.

The program should be designed to educate and inform the target audience on:

- nature of radiation,
- devices that produce radiation,
- radiation detection,
- radiation measurement,
- radiation protection,
- first aid for the irradiated,
- medical care for the irradiated, and
- procedures for the repair of irradiated parts of the ship.

On board ships, attempted smuggling of radiological weapons, and the protection of the ship and crew are supervised by authorised ship and port officers. They are also engaged in other primary tasks on the ship. Therefore, it is recommended that special services in the ports are engaged in order to control ships and crew professionally and provide timely assistance in preventing smuggling, finding a suspected item, and organising protection.

It is proposed to educate seamen on handling instruments for measuring radioactivity. In order to protect the seamen from radiation, the proposed training would be aimed at reducing radiation, avoiding direct exposure, and finding shelter.

Accordingly, the IMO would be in charge of laying down procedures of the conduct of the ship and crew in the event of radiation on board the ship.

The IMO and the *International Labour Organization – ILO* should prescribe the safety at work methods with respect to activities in the vicinity of irradiated areas.

In order to increase the level of protection against radiation hazards on board, officers and crew require additional education on radiation threats, symptoms and treatment.

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BIOGRAPHIE

Josip Kasum, Sc. D. was born on 6th May 1961, in Zagreb, Croatia. He was employed at computer maintenance of Ei Honeywell Bull. He worked as an independent designer in the electronic department of the company DALMA Split and as a research assistant for technical aspects of telecommunications from 1991 to 1993. He has been employed at Croatian Hydrographic Institute (HHI) since 1993. He actively participates in various scientific and/or expert projects within the HHI, such as ADRIA1/ADRIA2 – optical under-sea cable. He also works as the author and/or editor of publications from the fields of naval electronics, radio service and telecommunications and as the manager of system support and Director's consultant since 2000. From 2009 he is assistant director in HHI. He is a member of the Association for electromagnetic compatibility ELMACO from Split and an associate in two technical boards of the Bureau of Standards in Zagreb. He also worked abroad, e.g. in London, Great Britain, where he participated in the work of COMSAR, a subcommittee of IMO, in 1998 and 2003, and in various European countries, in accordance to the requirements of the Council for telecommunications of the Republic of Croatia and of HHI. He is a member of the Royal Institute of Navigation in London. He is a member of System Dynamics Society, University of Albany, USA. He is a permanent expert witness at the County court and Commercial court in Split. Pursuant to the Decision of the Croatian Parliament he has been a member of the National Council for higher education since 2004-2009. He has been a member of the Scientific Traffic Council at Croatian Academy of Arts and Sciences since 2005 He is registered in the Registry of researchers of the Ministry of science, education and sports of the Republic of Croatia, reg. number 222324. He has published 24 scientific papers in relevant scientific magazines and scientific conferences, and a series of books, researches and studies.

Capt. Pero Vidan, Graduate engineer was born on 9th September 1976 in Metković, Croatia. He graduated from the Faculty of Maritime Studies in Split in 2000 and then navigated at various ships for *Splitska plovidba*, M*editeranska plovidba*, *Lauritzen Coo*l, *Armada Swiss*, S*eatrade*. He is the Captain of the ships above 3000 GT. Since 2006 he has worked as an assistant at the Maritime Faculty in Split for the practical courses of Practice and Electronic Navigation. He is a member of the Maritime Captains Association He is registered in the Registry of researchers of the Ministry of science, education and sports of the Republic of Croatia, reg. number 288456. He is doing his post graduate studies at the Traffic Faculty in Zagreb. He has published 12 scientific papers in relevant scientific magazines and scientific conferences.

Tomislav Skračić, MA was born on 26th March 1964 in Šibenik, Croatia. For 20 years he lived in Zadar where he completed his secondary and undergraduate education. He has been living in Split since 1993. Since 2005 he has worked as lecturer of English language at Faculty of Maritime Studies in Split. From March –December 2006 he worked as teaching assistant at University of Zadar, department of French language and literature. He was English teacher in primary and secondary schools, part-time lecturer of English language at Split polytechnics (2002) and interpreter at international humanitarian NGO: "Médecins Sans Frontières" from Belgium (Split office), International Committee of the Red Cross from Geneva (Split office), and "Pharmaciens Sans Frontières", France (offices in Split and Sarajevo) 1993-1997. He has published 12 scientific papers in relevant scientific magazines and scientific conferences.