SOLAS Chapter II-2, Regulation 10.10.4

Fire Fighter Communication

Fire Fighter Radios

White Paper

Revision Record

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AA	CHC	2015-1	Preliminary release
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1 Preface

On November 30, 2012 the Maritime Safety Committee adopted Resolution MSC.338(91) among which, Chapter II-2 "Construction – Fire Protection , Fire Detection and Fire Extinction" is of specific interest to firefighting process and technology.

This White Paper is focused on the above mentioned Chapter II-2 and in particular Regulation 10 "Fire Fighting", but issues from other parts of Chapters I, II and III are also taken in to consideration when reflecting on Chapter II-2, Regulation 10.10.4 "fire-fighter´s communication".

1.1 Purpose

The intention of this paper is to reflect on the new SOLAS requirement for radio communication equipment for fire-fighters on board vessels.

This paper is not an interpretation of the requirement but rather a reflection on issues related to the implementation of the fire-fighter communication regulations introduced, which in the Resolution MSC.338(91) text may seem unclear or not self-explanatory. In addition, this paper reflects on various issues which may be considered concerning the firefighter´s communication equipment – the "two-way portable radiotelephone apparatus".

2 SOLAS Chapter II-2, Regulation 10.10.4 - Fire fighter´s communication

The wording in the SOLAS Chapter II-2, Regulation 10.10.4 is:

For ships constructed on or after 1 July 2014, a minimum of two two-way portable radiotelephone apparatus for each fire party for fire-fighter´s communication shall be carried on board. Those two two-way radiotelephone apparatus shall be of an explosion-proof type or intrinsically safe. Ships constructed before 1 July 2014 shall comply with the requirements of this paragraph not later than the first survey after 1 July 2018.

In the following the expression "Two-way portable radiotelephone apparatus" shall be referred to as "**fire-fighter radios**".

SOLAS Chapter II-2, Regulation 10.10.4 shall be referred to as "**Regulation 10.10.4**"

2.1 For ships constructed on or after 1 July 2014

Vessels constructed from July 1st 2014 have already implemented the requirement.

With a present average of approximately 2,000 newbuildings per year only a minor amount of the total world fleet of SOLAS vessels are already fulfilling the requirement.

The requirement for fire fighter radios is approximately 6,000 to 8,000 units annually for newbuildings.

2.2 Ships constructed before 1 July 2014

The amount of vessels constructed before 1 July 2014 (the existing fleet) is approximately 89,000 vessels of which approximately 60,000 – 65,000 are covered by the SOLAS regulation and therefore by Regulation 10.10.4

Other non-SOLAS vessels are expected to implement Regulation 10.10.4 although the amount of such vessels is difficult to estimate since some of these will implement Regulation 10.10.4 on the owner's voluntary decision.

The requirement for fire-fighter radios until final implementation date on 1 July 2018 is approximately 260,000 to 300,000 units over a period of less than 3 years from now, which will pose an exorbitant requirement for timely delivery prior to survey of the vessels trading worldwide.

2.3 Survey

In Regulation 10.10.4 the deadline for vessels constructed before 1 July 2014 to comply with the Regulation 10.10.4 is *"...not later than the first survey after 1 July 2018."*

Vessels are covered by various mandatory surveys during their active life time i.e. Radio Survey, Survey of Life-Saving Appliances, Surveys on structure, machinery etc.

The time for the various individual surveys may be different depending on type of vessel, type of survey, type of equipment, the anniversary of the vessel and date of latest survey carried out.

Radio installations, including those used in life-saving appliances of cargo ships and passenger ships to which SOLAS Chapters III and IV apply, shall be subject to Initial Surveys, Renewal Surveys and Periodical Surveys at specified intervals.

Live-saving appliances are subject to similar surveys however i.e. radio installations are not part of the life-saving appliance survey.

The fire-fighter radios are described in SOLAS Chapter II-2, Regulation 10.10.4.

The extent of the individual survey naturally depends on the individual equipment under the SOLAS requirements specified in IMO performance standards further detailed in IEC/ISO test standards for such equipment. These requirements are enforced by the vessels flag state. For vessels flying the flag from an EU member country and for many vessels flying a flag of convenience these requirements are for radio communication

equipment administrated under the Marine Equipment Directive (MED). Equipment not covered by the MED administration is managed under the R&TTE Directive, which is being replaced by the Radio Equipment Directive (RED). In both the R&TTE and the new RED maritime electronics are required to be approved according to EN/IEC 60945, and the relevant radio communication standards, i.e. ETSI to ensure that equipment is suitable for use in the marine environment and has passed a predefined set of test to prove the performance standards.

The inspection and survey of ships, as to regards of the enforcement of the provision of the regulations and granting of exemptions therefrom, is administrated by the flag state and carried out by officers of that administration, but more often this is entrusted to the inspections and surveyors nominated for the purpose or to organizations recognized by the Administration.

The surveyor will carry out inspection and surveys requested by the appropriate flag state and if, determined by the surveyor that the conditions of the ship or its equipment does not correspond substantially with the particulars of the certificate in question, shall immediately ensure that corrective actions is taken. Additional to the inspections required by the flag state, port states are able to perform additional inspections on their own initiative.

When applicable, the Government of both port state and flag state shall ensure that the ship is seaworthy and sail without danger to the ship, the environment, and persons on board.

2.4 Fire Party

According to Chapter II-2, regulation 10.10.2.1 all ships shall carry at least two fire-fighter´s outfit.

According to Chapter II-2, regulation 10.10.2.2 an additional fire-fighter's outfit is required for passenger vessels depending on the design of the passenger vessel / cruise ship; i.e. length of passenger spaces, number of decks, number of vertical zones and number of passengers.

According to Chapter II-2, regulation 10.10.2.3 an additional two fire-fighter's outfits shall be provided on tankers.

The International Code for Fire Safety System (FSS Code), resolution MSC.98(73), Chapter 3, Regulation 2 *"Fire-fighter's Outfit"* defines and describes the scope of the fire-fighter outfit such as type approved electric safety lamp, rubber boots, rigid helmet, explosion proof electrical safety lamps (for tankers), type approved lifeline, type approved breathing apparatus etc.

The fire-fighter's outfit shall be kept ready for use in an easily accessible location.

Fire-fighter's radios as required by Regulation 10.10.4, is additional to the above fire-fighters outfit and intended for the Fire Party.

Therefore, the total number of these radios to be carried on board will depend upon the number of fire parties detailed on the Muster List rather than the number of fire-fighter outfits.

Each Fire Party must have at least two of these dedicated radios and as fire-fighters may need to use Direct Mode Operation (DMO[1]) during fire-fighting operations or if the Fire Party consist of more crew members than the actual fire fighters, i.e. incident commander, the actual number of fire-fighter radios may vary from vessel to vessel as more than two radios may be required for each Fire Party.

The purpose of these fire-fighter radios is to provide a dedicated means of communication between a team of fire fighters entering the space, and the crew member located outside the space who is assigned to control this team.

1 DMO: Direct Mode Operation, communication between two or more radios on same frequency. Please also refer to Section 3.

3 Fire Fighter Radio

In the following the expression *"Two-way portable radiotelephone apparatus"* shall be referred to as "**fire-fighter radio**".

3.1 Performance standards

To date, IMO has not yet set the performance standards for the above fire-fighter radios but, in order for such equipment to meet the explosion proof or intrinsically safe requirements the radio telephone apparatus must be certified in accordance with relevant standards for equipment and protective systems intended for use in potentially explosive atmospheres, and maintained as such, for example: Directive 94/9/EC (ATEX) - with approval rating such as II 2G Ex ib IIB T4 or II 2G Ex ib IIC T4.Temperature rating "T3" may be accepted instead of "T4" but the T4 rating will cover all types of vessels including tanker vessels.

Radios tested and certified according to recognized maritime standards have passed comprehensive testing for the specific marine environment as set forth in the standards i.e. EN60945, EMC test, drop test, IP-grade test, Ex approvals from notified test facilities, to mention a few.

In addition accessories for such radios have passed similar tests and therefore tested and certified to have full functionality with the radio.

The fire-fighter outfit as well as the use of breathing apparatus will leave limited possibility of using a portable radio during the fire-fighting operation.

The IMO Fire Safety Code does not describe the design of the Fire Fighter Radio in this regard.

From a user point of view the fire-fighter radio should be designed for use with large gloves, possibility of being warn underneath the fire-fighter suit, for smoke divers wearing breathing apparatus, being able to connect to breathing mask and for Incident Commander being able to connect to helmet headset.

The range of tests to document the performance of the fire-fighter radio is based on international standards and therefore recognized by surveyors worldwide.

It is the ship's responsibility to demonstrate that the radios are fit for purpose, i.e. that they are able to work within the environment to be expected in a fire scenario, that their operating range is sufficient and that they are safe.

3.2 Frequency band

Regulation 10.10.4 does not state what frequency band the fire-fighter radios should be working on. ITU however is specifying which frequencies are to be used for on board purposes. For UHF this is specified in ITU-R M.1174-3, and for VHF the requirements are in Appendix 18 of the Radio Regulations.

To obtain the maximum coverage in confined areas on board a vessel, the use of the UHF is the most commonly used frequency band working in the range of 457 MHz to 467 MHz for maritime use.

According to the international radio regulations, six UHF frequencies are reserved for maritime use (on board communication) which can be increased by using 12.5 kHz spacing instead of 25 kHz spacing.

3.3 UHF on board communication

UHF frequencies are the most common for on board communication due to better propagation inside metal structures.

Using the fire-fighter radio on the same frequency as the daily on board UHF frequencies will provide the possibility of establishing communication between existing radios for on board communication and the fire-fighter radio.

Considerations should however be made on the programming of frequencies (channels) for all radios on board.

In DMO communication all radios working on the same frequency (channel) will have the possibility to send and receive on this channel. A dedicated channel should be reserved for the Fire Party for use only during fire-fighting operations in order to avoid disruptive interference from other radio communications on board not being part of the operation.

This will minimize the risk of interruption of communication between members of the Fire Party from other radios on board, but it will not prevent interference from other nearby vessels which may use the same frequency (channel) for daily operations.

To avoid interference from other nearby vessels the fire-fighter radio should be capable of having frequencies (channels) programmed with Continuous Tone Coded Squelch System (CTCSS) which is a frequency code programmed with the frequency (channel) of the fire-fighter radio. Only radios with this code on this specific frequency (channel) will be able to communicate.

Shifting the fire-fighter radio to any other frequency (channel) without CTCSS will again open up for communication with all other radios on board or nearby.

Using CTCSS is also known as Trunked Mode Operation (TMO) which is also needed when using radio repeaters i.e. for use in confined areas.

3.4 Confined area

The structure of a vessel is more or less comparable with the structure of a faraday cage – lots of steel construction surrounding the radios in use. In a fire-fighting situation, this gets even worse since fire doors and fire dampers have been activated and closed, leaving very limited, or no penetration of radio signals.

UHF radios provide the best available penetration possible within such areas and between each fire-fighter and/or the incident commander on deck.

The sensitivity of the fire-fighter radio transceiver is of great importance in order to maintain proper communication at the limits of the radio coverage. Additionally, the correct position of the portable radio on the fire-fighter outfit must be considered to reduce the reduction in radio signal due to body loss.

The vessel may be constructed in such a way or be of such size that radio communication between some positions on the vessel is impossible to and from the Fire Control Station (i.e. thruster compartments, shaft tunnel, engine rooms, amount of decks etc.).

This is often and most sufficiently solved by a system of distributed antennas or leaky feeder antenna cable combined with radio repeaters in order to provide full radio coverage throughout the vessel.

Distributed antenna systems are commonly working on UHF frequencies and may therefore by minor reprogramming of the fire-fighter radio extend the indoor coverage in confined areas – a vital improvement of the safety of the Fire Party as well as beneficial for the day to day work radio communication.

Use of radio communication via a radio repeater system has minor impact on the Push-To-Talk (PPT) functionality on portable and fixed radios in the system. The CTCSS code needs to open the radio repeater to establish the communication which delays the PTT functionality by no more than 300ms.

If considered to be installed, a distributed antenna system should be based on a link calculation provided by the installer and based on a vessel's General Arrangement drawings to ensure maximum performance throughout the vessel with due respect to signal loss in cables, connectors, splitters etc. This calculation, in combination with the sensitivity of the fire-fighter radio transceiver, will provide the best possible solution for the individual vessel.

Distributed Antenna Systems are not part of SOLAS Chapter II-2.

3.5 Storage

According to Chapter II-2, Regulation 10.2 fire-fighter's outfit shall be kept ready for use in an easily accessible location which is clearly marked.

Regulation 10.10.4 does not provide recommendation on the placement of fire-fighter radios.

As a fire on board a vessel can spread within minutes it is of paramount importance that there is easy access and that the fire-fighter outfit and equipment is ready to use. This is typically secured by placing it in permanently and clearly marked locations i.e. lockers on deck or in passageways.

Depending on the type or size of the vessel, more fire-fighter outfits may be required and this will then be stored in widely separated locations.

Fire-fighter radio can be stored together with fire-fighter's outfit to secure easy access and availability together with the fire-fighter's outfit instead of wasting valuable time spent collecting fire-fighter radios from a separate location.

Fire-fighter radios might be marked or coloured to identify such radios from other on board portable radios with regards to ensure that they are kept ready for use and that they are recognizable to the surveyor during survey.

To secure readiness of the fire-fighter radio, they may be placed in chargers providing constant charge to the radio battery, but considerations should be made since chargers are not explosion proof and must be placed outside hazardous areas.

Radio batteries will slowly be impaired when being constantly charged and although regular Fire Drills includes checking of relevant communication equipment and also read-out of battery status from the radio display, considerations should be made to have i.e. emergency back-up power battery pack for instant use during the charging time for the ordinary battery.

Emergency back-up batteries will shorten the time from the outbreak of a fire to the deployment of the Fire Party in case radio battery for one or more fire-fighter radio is not usable (i.e. not charged)

Charging time for a radio battery for portable radios which is fully discharged is typically between 4 to 5 hours.

Emergency batteries are non-rechargeable but will maintain their capacity for a period of 5 – 6 years if not activated before expiry.

Emergency batteries will typically provide power for the radio in a period of 6 to 8 hours.

3.6 The radio

Regulation 10.10.4 briefly describes the fire-fighter radio; *".....two-way radiotelephone apparatus shall be of an explosion-proof type or intrinsically safe."*

The fire-fighter radio mainly consists of a portable UHF radio transceiver, a battery and an antenna. The radio has various buttons and controls for operating change of channels, adjustment of squelch and a PTT button.

For read-out of battery charge status and other important information as well as channel selection and similar settings, a display may be part of the radio for the ease and safety of operation.

The transceiver contains the software of the fire-fighter radio, i.e. various channels programmed to the radio, features such as audio readout of channel selection in headset, name of channels etc.

The housing of the fire-fighter radio is made from materials which will prevent the radio from damage even in extreme conditions during operation. Fulfilling recognized standards for maritime communication equipment will ensure that the unit has passed sufficient test carried out by an accredited laboratory. These tests include several well defined setups like durability and resistance to environmental conditions, heat test, vibration, rain and spray, corrosion to mention a few aspects of the extensive test scheme.

As the fire-fighter radio shall be of an explosion-proof type or intrinsically safe, the radio transceiver, the battery, the antenna, the belt clip and any other parts forming the complete the fire-fighter radio shall be tested and approved accordingly.

The fire-fighter radio may have a coloured housing to distinguish the radio from other on board radios used for normal operations. This is also known from portable GMDSS VHF's which are typically yellow or orange and only meant for emergency use.

3.7 Radio accessories

Regulation 10.10.4 does not recommend the scope of possible accessories for the fire-fighter radio.

Being meant for use by the fire fighters in the Fire Party, fire-fighter radios must be capable of being used by crew wearing full fire fighter suits and full breathing apparatus/smoke diver equipment and the fire-fighters not involved in smoke diving wearing fire-fighter's outfit and helmets.

It should therefore be possible to connect relevant accessories to the fire-fighter radio in order to operate the radio in a safe and efficient way.

Typically an accessory kit for fire-fighters will consist of a PTT unit, or a Remote Speaker Microphone (RSM) and a headset.

All accessories need to be explosion proof and to have been tested and approved with the fire-fighter radio in order to fulfil the Ex certification of the radio as well as to ensure compatibility as i.e. impedance in headsets etc. may vary from type to type and cause severe reduction in audio quality in case of mismatch between radio and accessory.

PTT's can be used by fire fighters as a connection between the helmet or smoke diver mask to activate the fire-fighter radio. It should be of ruggedized design as well as shaped for easy operation with heavy gloves or even when wearing under the fire-fighter suit, with the pressure of i.e. the elbow. It should be designed to prevent unintended activation by the fire fighter.

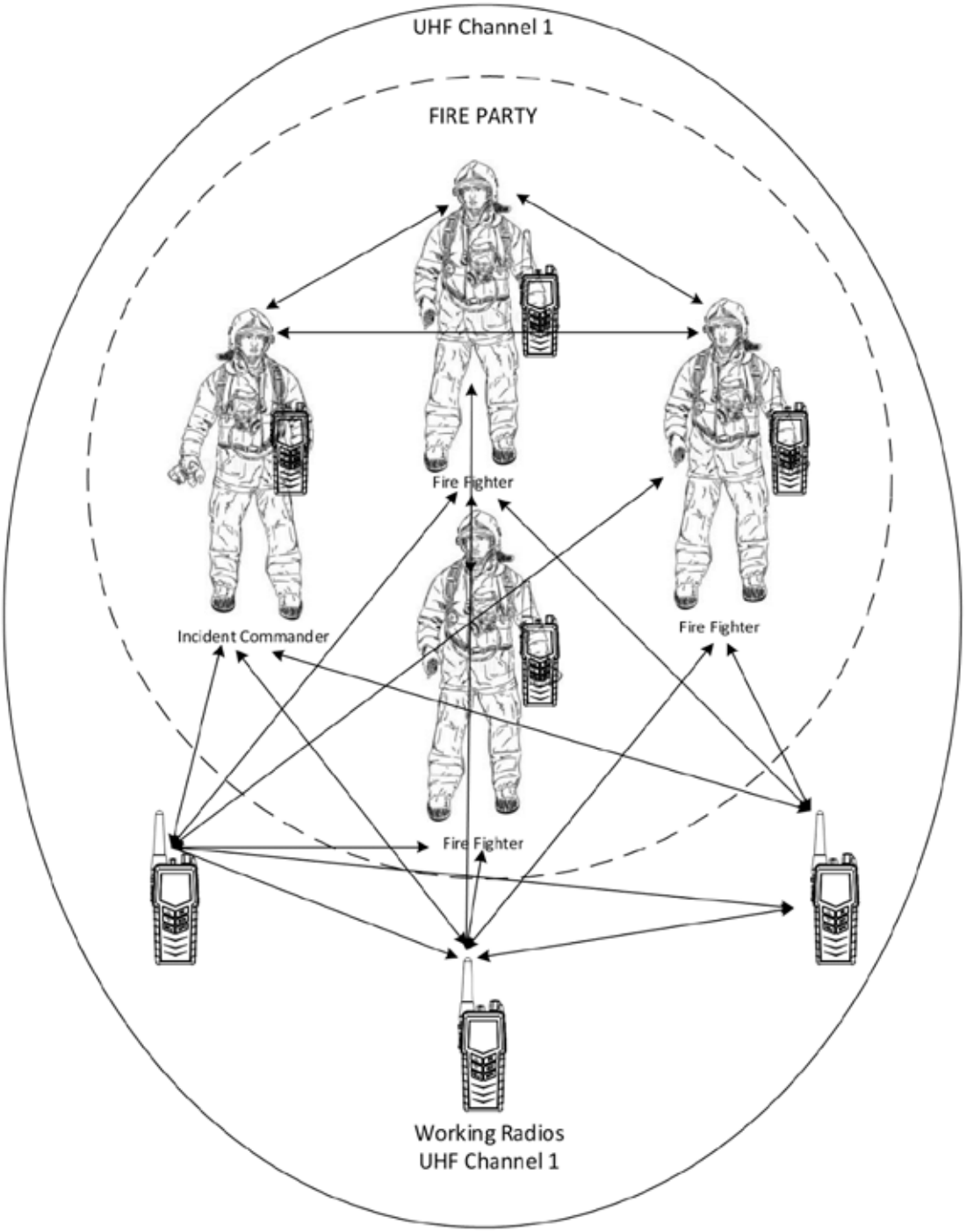
The PTT has no built in microphone or loudspeaker as these are placed in the fire fighter's mask communication or headset. When the PTT is connected to the fire-fighter radio the microphone and loudspeaker in the radio is disabled and all audio including possible channel readout is done in mask or helmet unit.

RSMs can be used by fire fighters not wearing smoke diving masks and it may or may not be used in connection with a headset. The RSM includes a Push-To-Talk button, a built in microphone and a build in loudspeaker as well as a connector for headset.

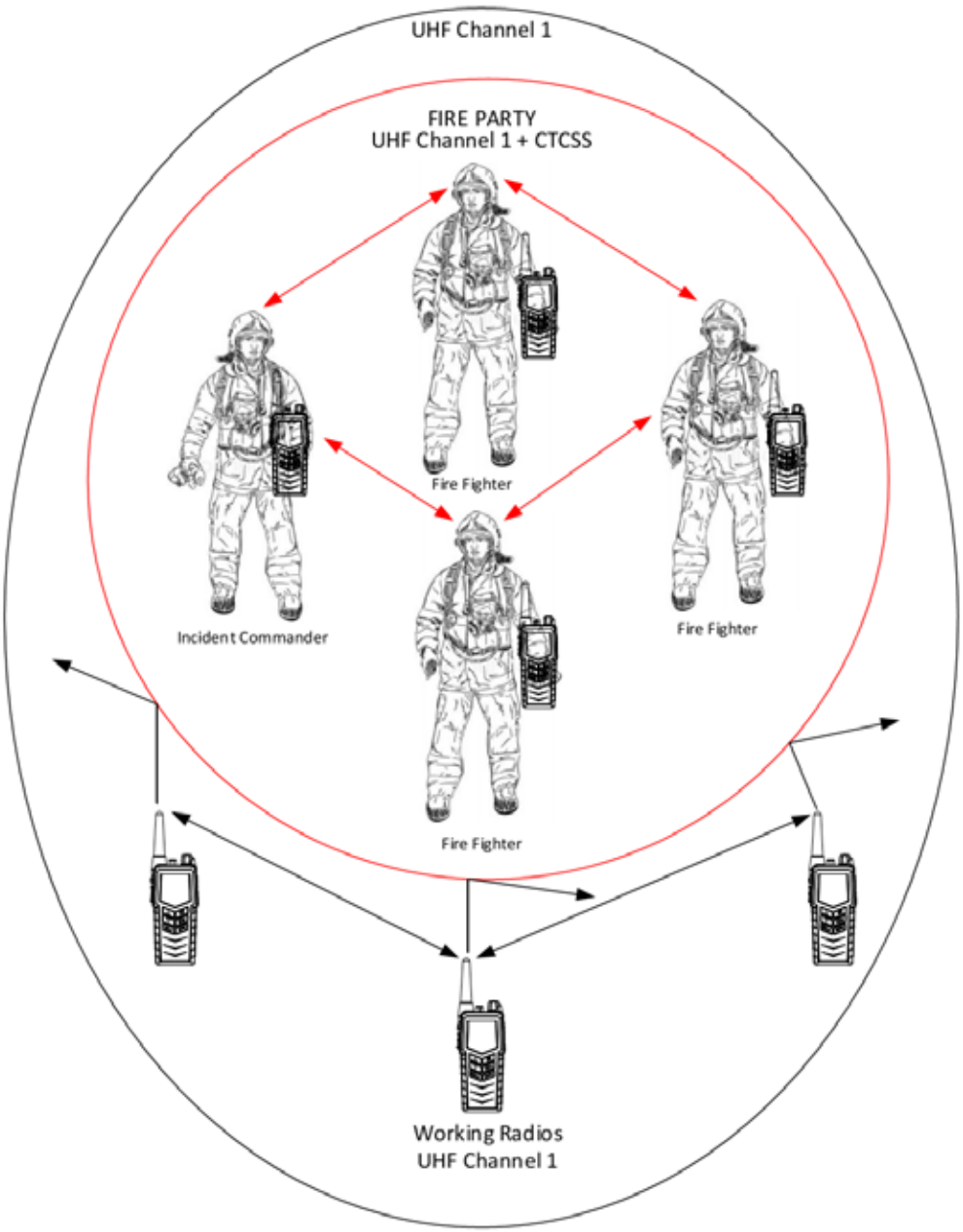
When a headset is connected to the RSM the loudspeaker and microphone is disabled in the fire-fighter radio. When a headset is connected to the RSM, the microphone and loudspeaker functions are transferred from the RSM to the headset with boom microphone or skull microphone.

For some fire-fighter radios the change of channels will be confirmed in the headset by audio readout as the fire fighter may not have the option of seeing the channel selection button or display of the fire-fighter radio.

3.8 Direct Mode Operation



3.9 Trunked Mode Operation



4 Abbreviations

SOLAA	Safety Of Life At Sea
UHF	Ultra-High Frequency
VHF	Very High Frequency
GMDSS	Global Maritime Distress & Safety System
DMO	Direct Mode Operation
TMO	Trunked Mode Operation
IMO	International Maritime Organization
CTCSS	Continuous Tone Coded Squelch System
DAS	Distribution Antenna System
PTT	Push-To-Talk
RSM	Remote Speaker Microphone
IEC	International Electrotechnical Commission
ATEX	ATmosphères EXplosibles