MARITIME SAFETY COMMITTEE
75th Session
Agenda Item 4

MSC 75/4/xx
Date: March 2002
Original: ENGLISH

LARGE PASSENGER SHIP SAFETY

The use of Directional Sound as an aid to passenger evacuation

Submitted by Germany and the United Kingdom

SUMMARY

Executive summary: This paper follows on from the United Kingdom submissions to FP 46 (FP 46/11/2 & FP 46/INF.9) concerning developments in the use of directional sound as an aid to passenger evacuation, provides answers to questions raised about the directional sound system and proposes an amendment to SOLAS to allow the use of such technology as an alternative to low-location lighting.

Action requested: Paragraph 25

Related documents: MSC 74/WP.6, FP 46/11/2, FP 46/INF.9, MSC 75/INF.xx

Background

1 The existing SOLAS regulation II-2/41-2 paragraph 4.7 (re-numbered as regulation II-2/13.3.2.5.1 in the revised text that is expected to enter into force on 1 July 2002) was developed as part of the Organization's review of the regulatory framework in the aftermath of the *Scandinavian Star* tragedy in April 1990. In this disaster, many passengers died as a result of asphyxiation and smoke inhalation because they were unable to find an escape from smoke-filled corridors in passenger accommodation. In this regulation the following performance requirement is specified:

The marking must enable passengers to identify all routes of escape and readily identify the escape exits.

2 The remaining text of the regulation details requirements specific to the provision of low-location lighting.

Experience in the use of low-location lighting

3 Thankfully, fires on passenger ships where passengers have to evacuate from or via smoke-filled spaces are rare. Experience in the use of low-location lighting in emergency situations is therefore limited.

4 However, in paper FP 46/INF.7 the Unites States reported that, during the fire that broke out on the *Nieuw Amsterdam* on 23 May 2000,

By the time the passenger re-entered the corridor, it had become filled with smoke. Crouching to move along the corridor, the passenger became disoriented and was eventually found by a crewmember and taken to safety. The ship's electroluminescent low-location lighting system was in operation.

5 There have also been difficulties encountered when installing low-location lighting systems in deciding where the strips should be fitted, especially in large stairway enclosures and large open public spaces that form part of an escape route.

Introduction

6 Noting the reasoning behind the development of the current regulation and its underlying performance requirement – as provided in paragraph 1 above – the United Kingdom believes that an alternative technology now exists that *"enable[s] passengers to identify all routes of escape and readily identify the escape exits."* This is the use of directional sound – a technology that has already been successfully tested as an aid to evacuation in buildings, where such systems have been installed, and by the aircraft industry.

7 At its 46th session, the Fire Protection Sub-Committee considered two United Kingdom submissions concerning the use of directional sound as an aid to passenger evacuation. FP 46/11/2 presented the concept and technology of directional, broadband sound as an aid to passenger evacuation. This was supported by FP 46/INF.9, which reported the analysis of directional sound trials carried out by the University of Strathclyde. Further details of the technology and the extensive testing programme that has been undertaken to date are available on a website – that delegations are invited to visit prior to discussions at MSC 75, especially the Frequently Asked Questions (FAQ) section - at:

www.directionalsoundevacuation.com

A Compact Disc that includes video of the onboard trials is also available from:

webmaster@directionalsoundevacuation.com or the UK Maritime and Coastguard Agency - phone +44 23 8032 9519

8 The results of the trials appear to be conclusive, in that the use of directional sound in smoke-filled spaces significantly improved evacuation times – even when the passengers are not provided a pre-briefing on how to interpret the sounds they hear. Evacuation times are also improved when there is no smoke since attention is drawn to exits that may not be easily visible, but nearer.

9 FP 46 agreed that the United Kingdom submissions referred to above presented interesting new technology. However, clarification was requested regarding several aspects of the directional sound system. This paper provides the answers to the questions raised.

Discussion at FP 46

10 The following information is provided in response to the questions raised at FP 46 that are recorded at paragraph 3.22 of the FP 46/WP.10 - the draft final report of the meeting.

11 ***Directional sound beacons might not be heard above, or distinguished from, the background sounds likely to be experienced in an evacuation situation.***

.1 The General Alarm (or Fire Alarm) is most likely to be a narrowband sound and as such directional sound can be easily detected against that type of sound. A fire may be a broadband sound. However, research when testing new "man down" alarms for fire-fighters showed that they could identify directional sound clearly against equivalent sound levels of a fire and the background noise of their own breathing apparatus. This is likely to be due to the pulsing nature of the beacons that optimally activate our brains to a sensory stimulus. Directional sound has been tested in many very noisy environments, such as a quarry with large earth moving vehicles, where tests showed it could be detected easily as much as 17 dBA below the ambient (broad band) background sounds. In some cases these background sounds were as high as 95dBA.

.2 Professor William Albert Yost of Parmly Hearing Institute, Loyola University Chicago, USA has published 140 papers on different aspects of auditory perception over the course of his 32 years of research. He is widely regarded as a world authority in this field. In his paper ***"Auditory image perception and analysis"***, Professor Yost's research conclusions may be summarized as follows:

With reference to being able to hear multiple sounds at once, we have the ability to hear multiple sounds from different sources (e.g. people talking, helicopter overhead, wind blowing leaves, dog barking, etc.) at once, and we consciously decide which sound to attend to (which is not necessarily the loudest). The complex sound input has neural representation in the auditory system and contains the information, based on mechanical and neural mechanisms of the auditory periphery, which enables such discrimination to take place.

12 ***Whether it is technically necessary or advisable to integrate the new system with other existing onboard systems (e.g. Public Address, General Alarm, etc.)***

.1 The directional sound evacuation system uses it own set of specialised loudspeakers, placed at exit decision points to lead passengers along an evacuation route eg. corridors or open public spaces. It is not likely to be convenient or economic to use speakers of Public Address systems. The system is envisaged as a stand-alone system, manually triggered by the crew in response to a situation where evacuation is considered to be necessary. It may or may not be triggered at the same time as a General Alarm depending on the situation. Provision would need to be made to ensure that both General Alarm and Public Address systems were still effective when the directional sound evacuation system is activated. This may be achieved by interfacing to ensure that the directional sound system was temporarily suppressed while the General Alarm or Public Address systems were in use.

13 ***Whether the system has the capability of directing people away from a particular hazard without crew intervention.***

.1 The directional sound evacuation system, in its early implementation, is intended to be a simple equivalent to low-location lighting and Emergency Exit signs. Directional sounders will indicate the location of exits. Just like low-location lighting these exits may or may not be viable. The crew would trigger the system manually, typically from the bridge, when it was considered necessary.

.2 Clearly, in the case of a large complex vessel with multiple vertical zones, it may be desirable to split the operation of the system by zone or by deck. Selectively triggering or inhibiting the directional sound evacuation system manually by the crew could achieve this. However, such a system may be dependent on a sophisticated decision support system providing the information with which an informed decision could be made.

14 ***Clarification on how much information and early briefing was given to those involved in the trial described in FP 46/11/2, including the crew***

.1 When recruiting volunteers, a great effort was made to conceal from volunteers the details of the technology that would be tested. Press releases and recruitment posters made no mention of sound technology. The shipping company, on whose ship the trials were conducted, kindly agreed to lead the publicity to recruit volunteers by issuing the press releases and posters under their name.

.2 The briefings that were given were carefully scripted - so as to avoid any doubt about how much the volunteers knew in advance.

.3 The crew were not involved in any of the evacuation trials. There were safety marshals in place, but their role was purely to prevent injury and they played no active role.

15 ***Whether counterflow of passengers had been considered, e.g. people returning to their cabins in order to collect lifejackets etc. prior to evacuation***

.1 The directional sound evacuation system, in its initial implementation, just marks the direction and location of exits (like low location lighting and Emergency Exit signs). In this application it will not indicate that the exit is safe or preferred. Passengers will use information when they believe they need it. They make their own decisions as what to do or not do depending on their circumstances. For example, research has shown that passengers will gather their family group together before attempting evacuation, similarly, many passengers will attempt go to their cabins for medication or warm clothing before moving to assembly stations. In making that journey, they consciously ignore instructions telling them to evacuate, and would ignore the directional sound evacuation system in just the same way. However, once they have decided they do want to evacuate, they will use whatever information they can to assist them. Research has shown that many people on large passenger ships only ever find / choose one route to and from their cabins. This route may or may not include the fastest or closest route to an exit. Passengers who have gone initially to their cabin, and then want to start their evacuation route would find that directional sound evacuation beacons would assist them to locate the closest exit route - even if it was unfamiliar. Low-location lighting does not tell passengers which way to go to the nearest (or most appropriate) exit. The *Nieuw Amsterdam* incident (see paragraph 4 above) illustrated this when a passenger became disoriented in the corridor outside his own cabin that was filled with smoke from a fire eight decks below. The low-location lighting was in operation, but the passenger failed to find an exit.

Scope of proposal

16 The use of directional sound as an aid to passenger evacuation is within the remit of the Organization vis-à-vis the requirement in SOLAS chapter II-2 that marking must be provided that enables passengers to identify all routes of escape and readily identify the escape exits. Consideration of this issue is also consistent and relevant in the context of:

.1 the Organization's current objectives as specified in A.900(21), notably that the Committees are directed to focus attention on addressing safety and environmental protection issues, with particular emphasis on passenger ships;

.2 the subjects included in the Organization's long-term work plan - A.907(22) – notably the Specific Subject for MSC to consider of the "safe evacuation, survival and recovery following maritime casualties or in case of distress"; and

.3 the current initiative of the MSC to review the current regulatory framework regarding large passenger ship safety.

17. It is also considered that directional sound ties in with the "Gap" Analysis results related in the US paper FP 46/11/1. In particular, the United Kingdom believes that it would contribute towards: objective 3/task 1 – optimising survival time; objective 3/tasks 2, 4, 5 & 9 – crowd management & passenger demographics; and, objective 3/task 3 – crew and passenger notification issues.

Analysis of the issues involved - demonstration of compelling need

18. Whilst low-location lighting is intended to aid the evacuation by passengers in the presence of smoke, the United Kingdom believes that it does not always promote rapid escape, either because in such environments it necessitates movement by crawling (whether this is necessary or not) or because it is not sufficiently intuitive for passengers to use in an emergency situation and does not indicate the direction of the nearest exit.

19. Public spaces, such as atriums, casinos, and shopping areas are becoming increasingly popular, and are growing in size, on modern cruise ships and ferries. There are also large dining rooms that do not easily lend themselves to the use of low-location lighting. Clear line-of-sight vision from every part of these spaces to the exits may be difficult. It is therefore proposed that, as well as considering the attached amendment to SOLAS to allow the use of directional sound evacuation systems as an alternative to low-location lighting where this is currently required, the Working Group on Large Passenger Ship Safety should be asked to consider if this new technology would be of benefit if fitted to facilitate the evacuation of these spaces.

Analysis of the issues involved - benefits, costs and legislative and administrative burdens

20. The benefits of this system are described above. It has been demonstrated in comparative trials to be at least as effective as low-location lighting, the existing aid to evacuation that SOLAS requires to be fitted, and has the benefits of being intuitive and its use in an emergency not being diminished or obscured by smoke.

21. The mandatory fitting of directional sound evacuation systems is not being proposed. Rather it is envisaged that it will be allowed as an alternative to the fitting of a low-location lighting system. No additional administrative burden is therefore anticipated and the legislative burden will be minimal in amending any national legislation based on the existing text of SOLAS chapter II-2. Market forces, as well as the layout of the ship and other factors, will play a part in the owner's decision as to which system will be installed on ships. However, for information, it is presently estimated that the fitted cost of a non-intelligent or non-decision supported directional sound evacuation system will be approximately 20 per cent below that of a low-location lighting system fitted to the same ship.

Draft amendment to SOLAS chapter II-2 and future work

22. It is proposed that SOLAS regulation II-2/13.3.2.5.1 (the revised version of SOLAS chapter II-2 that is expected to enter into force on 1 July 2002) be replaced by the following:

.1.1 In addition to the emergency lighting required by regulations II-1/42 and III/11.5, the means of escape, including stairways and exits, shall be indicated to enable passengers to identify the routes of escape and readily identify the escape exits. This may be achieved either by the fitting of:

.1 lighting or photoluminescent strip indicators placed not more than 300 mm above the deck at all points of the escape route including angles and intersections. If electric illumination is used, it shall be supplied by the emergency source of power and it shall be so arranged that the failure of any single light or cut in a lighting strip will not result in the marking being ineffective; or

.2 a directional sound evacuation system that has been evaluated, tested and applied in accordance with the Fire Safety Systems Code.

.1.2 Additionally, escape route signs and fire equipment location markings shall be of photoluminescent material or marked by lighting.

.1.3 The Administration shall ensure that any lighting or photoluminescent equipment fitted in accordance with paragraphs 3.2.5.1.1.1 and 3.2.5.1.2 has been evaluated, tested and applied in accordance with the Fire Safety Systems Code.

23. Appropriate consequential amendments will be required to the title and text of Chapter 11 of the Fire Safety Systems Code, that refers to a resolution to be developed regarding the evaluation, testing and application of directional sound evacuation systems. In this regard, it is proposed that the latest version of the draft "Publicly Available Specification Directional Sounders – Requirements and Tests PAS 41:2001" is used as a base text for further consideration. For the information of the Committee a synopsis of this PAS is provided in MSC 75/INF.xx. A full text of the latest draft can be accessed via the website referred to in paragraph 7 above. It is important to note that this PAS is based on the principle of performance criteria, rather than a technical specification of the sounder and the sound that is emitted. Consequently, directional sound evacuation systems will not be single sourced.

Availability of industry standards

24. No relevant industry standards exist, apart from the draft PAS referred to in paragraph 22 above.

Action requested of the Committee

25. The Committee is requested to consider the use of directional sound as an aid to passenger evacuation with a view to:-

.1 incorporating it into the existing regulatory framework, so that it is considered as an equivalent to the existing requirements in SOLAS Chapter II/2 regarding the provision of low-location lighting (see paragraph 21 above);

.2 reviewing its use in the evacuation of large public spaces, perhaps initially by developing an MSC Circular recommending that it be fitted in these spaces on new passenger ships (paragraph 18 above); and

.3 add a new item to the work programme of the Fire Protection Sub-Committee as a high priority with one session to complete (noting paragraphs 5.2 and 5.5 of Appendix 1 to MSC/Circ.931), and the provisional agenda of FP 47, to develop the draft text of a resolution on the evaluation, testing and application of directional sound evacuation systems (paragraph 22 above).

***