Sound is faster than light

Passenger trials

LAST October's *Solutions* feature on passenger ship safety mentioned that preliminary trials using directional sound to evacuate a passenger ship were showing promising signs of success. The trials were organised by Sound Alert, a commercial division of Leeds University.

Since then extensive trials have been carried out on board the Caledonian MacBrayne ferries *Isle of Arran* and *Caledonian Isles* in conjunction with Strathclyde University, Leeds University and the Maritime and Coastguard Agency. The results of the trials have vividly demonstrated the effectiveness of directional sound as an aid to effective evacuation of passenger vessels, particularly in circumstances involving fire. The trials also indicated that directional sound technology was apparently far more effective in guiding passengers to emergency exits than the currently preferred option of low-level lighting.

The results were in fact so encouraging that both the UK and Germany have submitted proposals to the IMO which, if adopted, would allow directional sound to be included as an optional alternative to low-level lighting in the SOLAS regulations. The matter is to be discussed at the 75th session of the Maritime Safety Committee this month.

No way out

The present SOLAS regulations making installation of low-level lighting mandatory were adopted by the IMO following the tragedy of the *Scandinavian Star* in 1990. The vast majority of fatalities in that disaster were, according to official investigations, caused by asphyxiation and smoke inhalation. Most of the passengers were apparently unable to locate escape routes in the smoke filled corridors of the ship. Low-level lighting was proposed as the solution and, since there were at that time no obvious alternatives, its use was officially sanctioned.

Thankfully there have been very few occasions since the IMO resolution was adopted to test out the effectiveness of low-level lighting. In theory of course it should work; in practice it would seem that there are a number of real problems associated with relying on low-level lighting in some circumstances. One real-life experience that did occur has been held out as proving the ineffectiveness of low-level lighting.

Confused and afraid

When the *Nieuw Amsterdam* experienced an on-board fire in 2000, one of the passengers who had entered a smoke filled corridor and crouched down both to avoid the smoke and to follow the low-level lighting was eventually rescued in a very dazed state. He told rescuers later that even with low-level lighting in operation he had become disorientated and confused and was unable to find an exit.

Some experts question the value of low-level lighting, pointing out that in very wide areas in smoke filled conditions, actually locating the lighting could prove just as difficult as seeing high level exit signs. This would be true particularly if it were installed around the edge of the space.

Others argue that, while in the early stages of a fire, smoke does indeed rise to the top of a space, in a very short time the whole void would be filled, furthermore if the fire were below the area, smoke could enter through the floor itself. Both situations would make low-level lighting less effective. There is also the passengers' natural reluctance to crouch down or crawl to be considered. Some volunteers in trials have said that they did not like to do this for fear of being trampled.

Blindfolded volunteers

The tests that were carried out on directional sound lent themselves to a direct comparison between the effectiveness or otherwise of both systems.

In the trials volunteers were put into groups of 20 so that each test could be carried out with a group that had no prior knowledge of the layout or escape

Trails of directional sound were carried out on Caledonian MacBrayne ferries

Evacuation times even in smoke filled conditions were much quicker using directional sound

routes that were to be used. In some of the tests the volunteers were blindfolded before being taken to cabins in an attempt to replicate the sort of confusion and loss of direction that many passengers experience in large unfamiliar ships. The volunteers only had a cabin escape notice to refer to, a situation that would be normal on most passenger vessels.

In all of the tests, the evacuation time was considered to be when 18 of the 20 volunteers had found a safe exit. The organisers explained this as taking into account the fact that in a real situation some people would ignore evacuation advice, perhaps because they were looking for friends or relatives, and that some would be incapable through injury or because they were intoxicated at the time. But since the same conditions applied to all trials they considered the results valid.

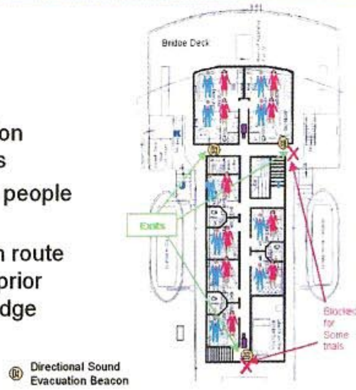
Different scenarios

Because the trials were carried out on real ships they could be planned to take into account many more scenarios and routes than would be possible in small test facilities ashore. Some of the test situations involved passing through open areas such as the cafeteria, or up and down staircases. In some cases the escape route was planned to be through areas normally off-limits to passengers and signed to that effect. Clearly it would not be possible to start a real fire for the trials so theatrical smoke was used instead. For every test the benchmark was set by the first group attempting to evacuate without any assistance from either low-level lighting or directional sound. The benchmark test would also be done without a briefing of what conditions were to be expected. All the following trials were conducted using permutations of the various means of assistance.

In the majority of trials, using sound alone resulted in complete evacuation in about half the time taken when using just low-level lighting. When both were used together the improvement over the sound alone trial was only very marginal. A fact which the organisers felt justified their faith in the directional sound system. *S*

Trial format – Cabins & Corridors

- Simple accommodation block – 3 exits
- 8 cabins – 20 people per trial
- Blindfolded on route to cabins, no prior layout knowledge



Data – 1 exit available

Trial	LLL	Sound	Briefed	18th exit time secs
S1-7		(No assistance)		286
S1-2	Yes			205
S1-9		Yes		109
S1-5	Yes	Yes	Yes	102 Average
S1-6	Yes	Yes		100 98
S1-8		Yes	Yes	82

The figures show the time taken to evacuate under different conditions

What is directional sound?

IN THE SYSTEM used for the trials the sound used is a broadband sound similar to "white noise" sirens used by some emergency services. In essence it consists of three different frequency sounds that between them allow the brain to recognise the sound even in a very noisy environment and to accurately locate the direction it is coming from. Because the frequencies of all three elements are relatively low, even some people who have hearing difficulties are able to benefit from the technology. Apart from truly deaf people, most hearing loss is of high frequency sounds such as the human voice.

Directional sound evacuation systems use dedicated speakers so they do not interfere with a ship's public address system. Systems can be very simple – like those used in the trials – consisting only of speakers placed at intervals along escape routes, or they can be made more sophisticated.

The system used in the trials has similar limitations to low-level lighting in that it is installed along a predetermined route. In a real emergency that route could be unsafe for any of a number of reasons. The technology could be adapted to make evacuation much safer by linking it to a central control from where selected routes could be activated guiding passengers to open escape routes and avoiding areas affected by the emergency. *S*