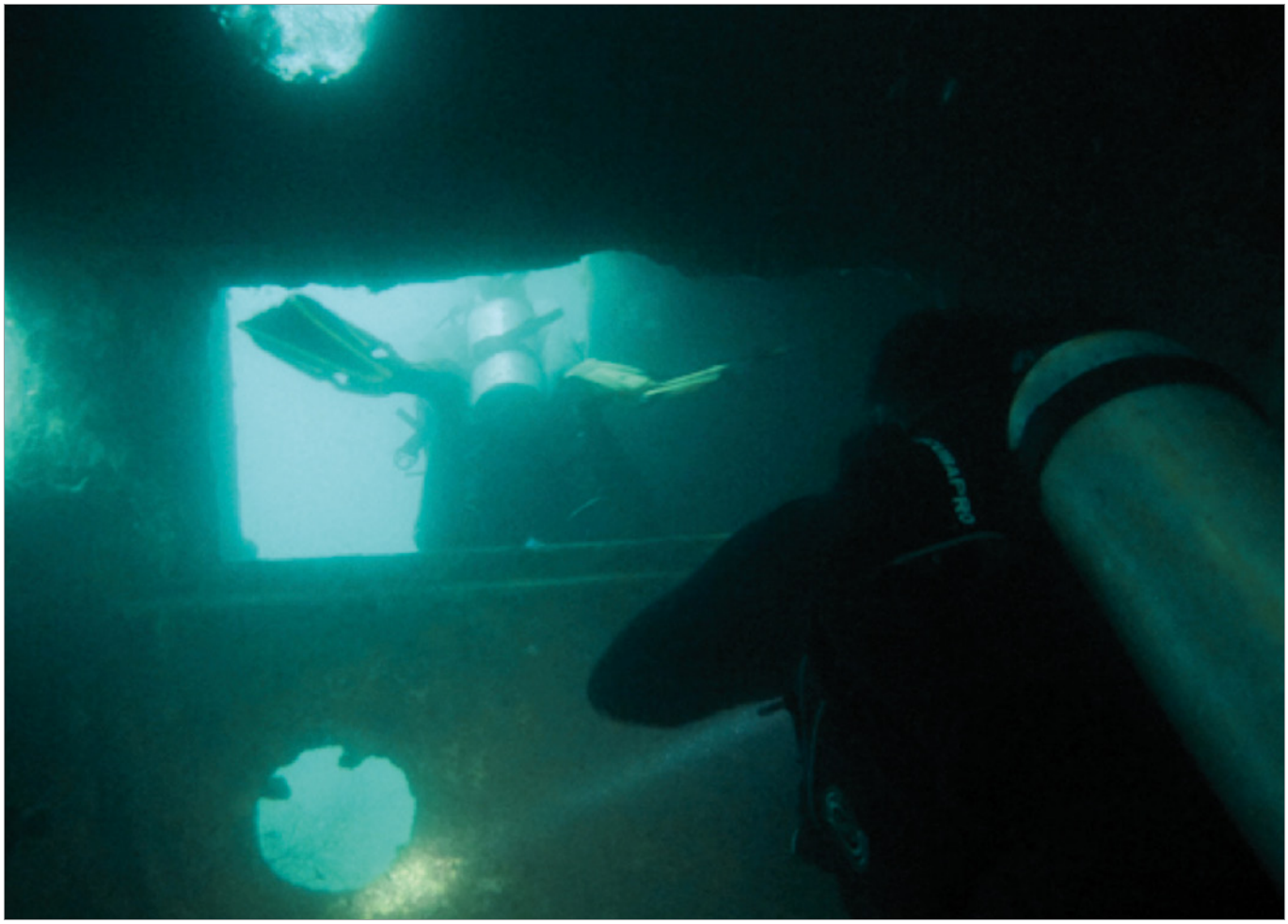


SPATIAL DISORIENTATION - THE AIR DOMAIN POINTS TO THE WAY OUT

Neil Ham MSc – Emergency egress subject matter expert – explores the condition of spatial disorientation and concludes how vital lessons learned from the air domain can help to save the lives of land personnel traveling in armoured vehicles.

By Neil A Ham MSc, Technical Lead & Business Partner, AeroGlow Ltd

Photo above: Divers penetrate wreck.

"Spatial Disorientation" - is the human inability to maintain the body's orientation and/or posture in relation to the surrounding environment (physical space) at rest and during motion.

Any divers that have ventured into shipwrecks or caves are more than aware of the dangers of spatial disorientation, and will be able to relate to the following example. When entering a ship compartment or enclosed space the water ahead is most often clear and it is very easy to remain confident with respect to knowing the way back. Most often, it feels as if only seconds are passing but the truth is it could be much longer. Suddenly, upon turning around to head home, the water has become heavily turbid (murky) as the diver realises that his/her fins have kicked up the silt behind them. The diver may instinctively try to check their air supply or compass but the silt is so thick that even their gauges cannot be read clearly. All natural sense of direction can be lost instantly, even comprehension of which way is up and down. In this situation just seconds remain to gain composure by identifying the route out before panic kicks in. Divers only make this mistake once, and lessons are learned rapidly by those lucky enough to have that opportunity.

Dunker Module.

Offshore helicopter operators/users, like divers, are aware of the risks of spatial disorientation in water as unfortunately the risk of offshore helicopters ditching into the sea remains significant. These risks stem back decades since oil rigs and offshore platforms were first introduced. As one would expect, in the early days of offshore helicopter operations the safety provisions to assist crew in the event of ditching were minimal. However, in the last 20 years many vital lessons have been learned, which are unfortunately the result of ditching fatalities. The Naval Medical Research Laboratory quoted over a decade ago: “Most people survive a water ditching but die because they fail to escape”.

Fortunately commercial and military standards now dictate that offshore helicopters will employ flotation bags, water-activated escape lighting, and in many cases crew carry personal air supplies. With respect to the prevention of spatial disorientation, it is escape lighting that is employed to mitigate the associated risks, along with live ‘dunker’ training. Live dunker training basically consists of being dropped (or dunked) into the water in a simulated cabin space. Crew are briefed to escape the cabin once all motion has stopped and the cabin is completely flooded – this can be at any particular angle; the most feared run being ‘lights out’ upside down (night time simulation). For many trainees including hardened aircrew this can be a traumatic experience. There is no doubt that a key catalyst for fear is spatial disorientation – leading to panic if the way out cannot be identified within the first few and vital seconds.

So how does this impact armoured vehicles and their users? Both the US and UK Military are now recognising the operational risks of operating near wadis, canals, and irrigation ditches, and are acting accordingly. Unfortunately the water found in these scenarios is likely to be extremely turbid which has compounded the associated safety requirements for escape lighting. The cabin spaces within many armoured vehicles are comparable to that of a support helicopter such that there is space for crew to become easily disorientated in an event. The risks associated with IED attacks and basic night operations are also at the forefront

... THE RISKS ASSOCIATED WITH IED ATTACKS AND BASIC NIGHT OPERATIONS ARE ALSO AT THE FOREFRONT OF SAFETY CONCERNS BY ARMOURED VEHICLE OPERATORS ...

Water risks in Theatre.

of safety concerns by armoured vehicle operators. Land vehicles are notoriously prone to rollover, and are vulnerable to the threat of IED attacks in Theatre. In these situations, spatial disorientation is becoming recognised as a key risk; this risk obviously being compounded by the presence of thick smoke and/or darkness.

Although dunker training is yet to propagate into armoured vehicle programs, UK and US soldiers entering Theatre do receive live roll-over training. Large roll-over simulation devices allow troops to progressively experience the disorientation, discomfort, and chaos associated with actual vehicle roll-overs. However, appreciation of these events does not wholly mitigate the risks associated with spatial disorientation. In a real scenario, should smoke be present in the cabin, as with water ingress, crew will need to orientate almost instantly as they will have only seconds to escape before panic leads to asphyxiation. It is these vital few seconds that hold the key to taking effective mitigation measures. Taking lessons from the air domain, the UK MoD have now fitted water, smoke, blast and roll-over activated egress lighting to all UK operated roll-over trainers known as the RODETs (Roll Over Drills Egress Trainers).

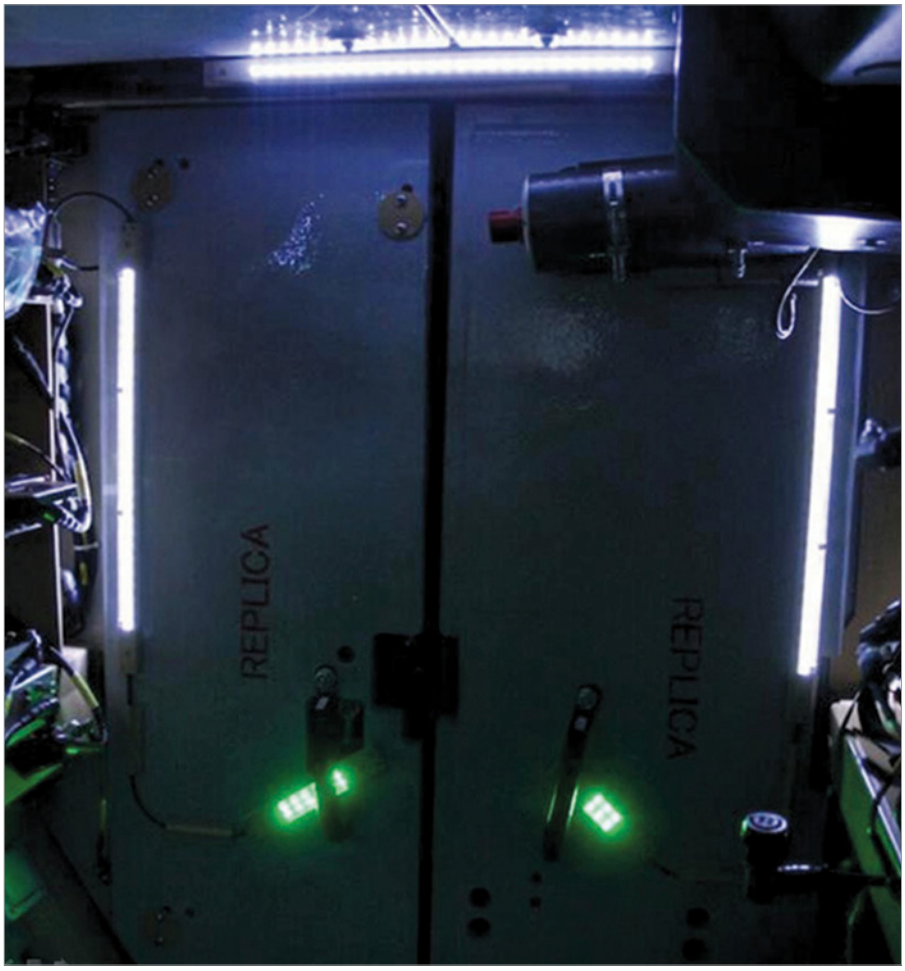
Egress lighting has also been procured by the UK MoD for a large majority of Theatre standard vehicles – some 2000+ systems. US Special Forces also operate a similar number of systems. Egress lighting should be designed to maximise the survivability of the crew by automatically illuminating all vehicle escape hatches, handles and vital escape equipment (such as spare air supplies). A proven configuration derived from the air domain is to have an inverted U around egress points to effect rapid spatial orientation, red lights to indicate safety equipment (for example battle locks) and green lights for door opening levers. Lighting must be effective through thick smoke, and turbid water. A major breakthrough in the military land domain in the last 18 months has been acceptance of some of the lessons learned from the air domain.

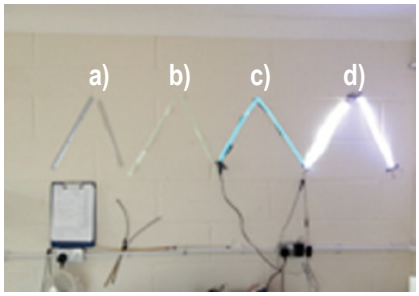
The author recalls the origin of these lessons:

One of the first tasks I undertook early in my professional career was to assess the use of photo-luminescent tape (glow in the dark tape) as a potential egress lighting aid for helicopters. Use of the tape would have been a quick fix and inexpensive solution for the air platforms

UK Roll-over trainer.
Courtesy of Army Safety Magazine, a Crown Copyright publication.

Lights fitted inside Roll-over trainer.





Clear Air - start of test


Dark conditions - in smoke at 1m


Dark conditions - in smoke at 2m


Dark conditions - in smoke at 3m

in question. Work that I have undertaken in this area has included using live subjects in turbid water trials to advance emergency egress knowledge. Looking back, vital lessons were being learned then that have influenced the evolution of military air and land safety.

As an example, one of the most interesting things that I have learned about photoluminescent tape over the years is that it can rapidly lose its charge in cold temperature. Dropping a sample of tape into icy cold water is the most effective way to assess this phenomenon. Also, although the tape can be seen reasonably effectively in clear air at night when our eyes are dark adapted, it cannot be seen effectively even in clear warm water by the naked eye. The human eye requires an air gap to focus on its intended object; in water without a diver's mask the light given from glow tape simply is not concentrated enough to penetrate and register on the retina. I do recall on one occasion being able to see the tapes glowing on the bottom of the pool from the pool side, even though I could not see them from only inches away from my eyes when underwater – which was to me a fascinating realisation of how things are not always as they might seem.

I spent approximately ten years as a specialist emergency egress advisor to UK MoD and US DoD and was involved in emergency egress assessments and military flight clearances for the majority of helicopters operated by the UK MoD; this included several US/UK government collaborations. The trials I managed ranged from egress lighting and guide bar assessments to open water sink rate and exploding canopy trials – involving the use of real airframes in open water. Dare I say these were the good old days when the grounds for comprehensive egress trials were easily justifiable in order to advance our knowledge.

In more recent years, having transitioned from the advice sector to supply, I have continued to refine my knowledge and advance the effectiveness of egress systems; in particular egress lighting into the land domain. In making this transition, the biggest challenge has undoubtedly been educating land- based users of the lessons learned in the air domain. For years, crew have happily been using glow tape in armoured vehicles as a means to mark egress points, and have in many cases made the assumption that it will help them in water and smoke. Trials have continued to gather further evidence to share with users in a campaign to raise awareness and dispel the many assumptions and myths surrounding escape lighting and emergency egress.

The photographs above are recent examples taken from internal smoke testing of LED point source lights in comparison to alternative lighting technologies. During this test a constant level of smoke was maintained. This was produced using a glycerine/water mix. The distance from the source was marked at increasing test points. Photographs of the systems were taken from increasing distance using equal exposure and shutter settings. The technologies were as follows:

a. Glint/reflective tape (with a torch as the source);
b. Photo-luminescent (glow) tape;
c. Electro-luminescent charged strip;
d. Point source LED based system at optimum frequency.

The above extract illustrates how appropriately designed point source LEDs can penetrate light long distances even in turbid mediums. Glint tape and photo-luminescent (glow) tape simply are not bright enough to have a positive

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effect. Electro-luminescent strips do offer some benefit and interestingly are often used in helicopters; however, the lack of a bright point source impacts its ability to be effective over long distances; the reason that these lights are still used in helicopters is probably due to fairly old standards such as MIL-PRF-85676A, which are arguably in need of review. Obviously, LED lights that are too bright should be avoided as to avoid dazzling personnel in favourable conditions. LEDs are most effective in the region of 7000 cd/m2, but also need to be mounted with an effective arc of visibility within an appropriate frequency. Unfortunately, it is not as simple as picking up some off the shelf LEDs for use as egress lighting.

CONCLUSION

The above provides a subject matter expert's view of some of the advances in land vehicle safety, particularly those centred on emergency egress from vehicles post event. The key message rising from this account has to be that: if, post-event, water or smoke is present in a vehicle cabin then crew must orientate themselves within the first few seconds before panic has the opportunity to take over. Instant recognition of the way out and positive spatial orientation suppresses panic and promotes composure post event. Offshore helicopter operators were aware of this risk decades ago and have since mitigated this with water and crash activated escape lighting. In many ways the risks facing armoured vehicle crews during an egress post event is higher than that of aircrew. The water in irrigation ditches and wadis is highly turbid, particularly in comparison to sea water – from which most aircraft standards stem from. As such the author is campaigning for armoured vehicle specific egress lighting standards to address lighting performance directly, and is actively involved in the design and supply of systems that exceed aircraft performance standards.

Given the lessons learned in the air domain, British Troops are now training with roll-over simulators incorporating automatically triggered escape lighting to mitigate the risks associated with spatial disorientation. There is also a Mandatory DefStan (0025 Part 4) that egress lighting must be fitted to armoured fighting vehicles. US operators are also beginning to take similar steps. Despite reasonable progress in the land domain, due diligence should continue to be paid to the effectiveness of available egress lighting technologies. Albeit effective as area markers in clear air, products such as photo-luminescent (glow) tape and glint tape (reflective tape) should be avoided for use as emergency egress lighting. Unfortunately, there are still users out there that rely on these systems as mitigation for water and smoke incidents. The most effective method of projecting light through turbid mediums is to use appropriately designed point source LED systems. Electrically charged panels, such as electro-luminescent panels, spread the light energy across larger surface areas, and are therefore less effective at penetrating long distances.

Who knows what the future holds, but hopefully one day all armoured vehicle operators across the globe will be taking measures to prevent the hazard of spatial disorientation. This may even include mandatory dunker training for land based personnel – sorry, troops! ■

... INSTANT RECOGNITION OF THE WAY OUT AND POSITIVE SPATIAL ORIENTATION SUPPRESSES PANIC AND PROMOTES COMPOSURE POST EVENT ...

ABOUT THE AUTHOR

Neil Ham has spent much of his professional career as an Emergency Egress subject matter expert and adviser to UK MoD and US DoD. His experience varies from managing live underwater egress trials to assessment of open water helicopter sink rate and canopy jettison trials. Since leaving MoD Boscombe Down Neil has brought his experience to AeroGlow Ltd and has made a successful transition into the defence supply sector. Neil holds an MSc from Kingston University and is an active researcher, developer, and frequently published author in the domains of land and air safety.

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