A VITAL ISSUE: ESCAPING WHEN A DISASTER OCCURS

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Keywords: passive fire prevention, escape route marking, luminescent pigments

Abstract:
Passive fire prevention and luminescent escape route marking systems are a vital necessity in buildings and on board passenger vessels. Existing EXIT signs and luminous direction indicators soon lose their 'visibility'. Worse still, many of them become completely invisible after a very short time. Finding a way out becomes difficult and panic is the result. When things reach this stage, the chances of survival for people involved are minimized. For this reason a new type of luminescent materials has been developed that enables people to evacuate from buildings and installations under the most severe conditions. The luminescent materials can potentially play a literally life-saving role in many places.

Introduction

When it comes to fire prevention we tend to think of fire extinguishers, fire alarms, smoke detectors and sprinkler systems. This is what we call active fire prevention. Passive fire prevention is a system technology for preventing or at least substantially reducing smoke and flame spread throughout the building in case of fire. This type of prevention is less appealing, because – unlike active fire prevention measures - it is not really visible in our daily environment. However, we should not ignore its importance!

BEELE Engineering/CSD International have been involved in passive fire prevention since the company was established in 1973. On the basis of field expertise stretching back almost 30 years, rubber and rubber-like compounds have been developed for use in fire-stopping systems for cable and pipe installations, which have proved to provide the ultimate performance available at this moment. The main achievement in our technology is the use of partly vulcanized rubbers which act as "compensators" for materials like cable sheathings which will be consumed by the fire or the heat, leaving substantial gaps in wall and floor penetrations and enabling at the very least smoke spread. When exposed to heat or flames, the rubbers start vulcanizing and expand heavily to form a solid rubber mass inside cable and pipe penetrations, and thereby close off these openings again. The higher the temperatures, the more fire-stopping material is created in this way. Smoke and fire no longer have any chance to spread out via the cable and pipe penetrations. The systems have been successfully tested to

the IMO Resolution A.754(18) and the European norm prEN 1366-3. For many, many years the sealing systems have enjoyed Type Approval for use in shipbuilding and offshore installations from classification societies all over the world.

Fires in installations are generally accompanied by a lot of smoke, and in most cases it is the dense and toxic fumes that are the killers. Due to the dense smoke it is almost impossible to find the way out, and panic is the result. When things reach this stage, the chances of survival for people involved are minimized. For this reason we have also developed additional safety measures for evacuation from buildings and installations under the most severe conditions.

The need for passive fire prevention

The population density is still on the increase, particularly in major cities. At the same time, the shortage of land coupled with its high cost has resulted in a trend to increase the height of buildings to live or work in. This means that, generally speaking, far larger numbers of people are present in a given building today than used to be the case in the past. We see the same trend in hotels, hospitals, homes for the elderly, shopping centers, cinemas, theatres, etc., which these days have to be designed on a large scale to make them cost-effective. If we also consider today's general individual mobility and observe the masses of people thronging airports, railway stations, ferries, passenger ships, etc., it is self-evident that any outbreak of panic due for example to a fire or a power failure will have potentially very grave consequences. For that reason, a high level of fire protection is legally required in many structures, and in many cases auxiliary power systems are prescribed as well.

However, none of this alters the fact that the possibility of a fire or a power failure can never be ruled out entirely. Evacuation of the people present, certainly in case of fire, is the number one priority. The large numbers of people and the general complexity of modern buildings have not made this any easier with the passing years. Admittedly, the time available for evacuation of personnel has been lengthened by the advent of smoke detectors to provide early alarm and sprinkler systems to attack the fire in its early stages, but time and again it appears retrospectively that 'there was just too little time'.

Making use of an engineered passive fire prevention system by dividing the building into so-called fire compartments creates barriers to prevent the easy spread of flame and smoke for an extended period. This is an absolute necessity to gain more time for evacuation and to keep a small fire small. Remember that the time needed for a small fire to become a large one can be just a matter of minutes without these provisions.
However, passive fire protection costs money, and an additional problem is that in many cases passive fire prevention is far from optimal due to ineffective application of these types of systems, limited legislation, and failing inspection of installed sealing systems due to lack of manpower and ignorance of the maintenance needs.

Outbreak of fire

Fire is unpredictable. It just happens, and not always to somebody else as we sometimes think to ourselves. Besides, fires vary from case to case. Don't forget that even a small fire can have far-reaching consequences. Due to the dense smoke it is

sometimes impossible to locate the seat of the fire. Fire-fighting is not easy then! The smoke accumulates under the ceiling and reaches temperatures of more than 1000 °C in a very short time. Once the smoke is set rolling by temperature differences, a perfect vehicle is created for the fire to spread rapidly. The hot fumes will cause spontaneous ignition of all materials they meet on their way, giving more and more acceleration to the spread of the fire. During this process a light failure may occur, making the overall situation even worse.
Under normal conditions an alarm will be generated in no time, but who will call the fire brigade? Possibly a check on the actual situation will take place first and perhaps an attempt at fighting the fire, but without an immediate warning being sent outside. Any delay in the warning can have quite a considerable impact on the professional firefighting effort afterwards. Small may by then already have become large.
How to escape from this life-threatening situation? What conditions do we face? Heat, dense and toxic smoke, darkness, sometimes individually, but in many cases a combination of all. Do you realize that the dense, hot fumes will close your eyes automatically within a very short exposure time, and that by then it is impossible to open them again? The human body protects itself in this way. At this particular moment you therefore become temporarily blind.

Human behaviour

While you are sleeping, the fire bell rings. It will take a while before you realize that something is going on. All of a sudden you are fully awake, and want to switch the light on. Where is the switch? Now you find out that there is no electricity at all. It makes you nervous. You want to dress, but where are your clothes? Where is your watch, your glasses, your wallet, your keys? You grow more and more nervous. After a while you think you have collected all your valuables. That bell is still ringing and makes you even more nervous. What next? Where to go? You realize you did not study the floor plan, but you want to get out! You are close to panic. Can you still think rationally? When you open the door there is total darkness outside, the corridor is already filled with smoke. You can’t see the EXIT signs any more. They are somewhere above the doors, meanwhile shrouded in dense smoke. Now it really is time for panic. As a result you may take an inappropriate escape route. The extremely dense and foul fumes make you more and more disoriented and normal breathing is almost impossible. The panic is further aggravated many times more if you are completely unable any longer to find the way out. And just imagine: to make matters worse, at this moment your eye-lids automatically close themselves. A horror scenario? Perhaps, but it has all happened before, with many casualties as a result.

What does darkness do to us?

Most of us live in our daily environment in an illuminated world. Put a city man in a forest at night-time and he will immediately feel insecure because of the darkness. Although total darkness seldom occurs out of doors, he is just not used to it anymore. Total darkness, however, scares us all, especially when we are in an unfamiliar environment. There is nothing for us to orientate ourselves by. Even worse, ship fires have shown that even where a crew had sailed on a particular ship for a long time, they no longer knew exactly where they were once a fire broke out and the lighting failed. The larger the room you are in, the worse it gets. Switching off all the light in a larger room or a theater will show you how this feels. Where to leave the room?

Possibly you will remember where you came in, but how to find this door with all these people around? Does the emergency lighting system work? It will not be the first case that the battery is flat. You really feel lost now. Consider that no fire or smoke is actually involved and that your life is not at stake. You hear the noise of people outside without knowing what is going on there. How do you feel?

The need for escape route marking

Of course you should take a look at the floor plan when you enter a building you are not familiar with. They are there to locate yourself inside the building and to find the nearest emergency exit just in case. How many people will actually do this and try out the escape route before locking their door for the night? For sure a very small percentage! When it really comes to the point that an evacuation has to take place, you have to rely on all kinds of means directing you to the exits. When the electric power fails, it is too late anyway to study the floor plan. Is the emergency exit to the left or to the right? You are lost right from the beginning.

In such a case you are fully dependent of the functionality of the escape route marking directing you to the emergency exits. At least assuming it is there at all or visible in darkness. If not, you are in trouble! In countless cases the presence of escape route marking is very inadequate, precisely because legislation in this field is rather poor. The electrically illuminated exit signs are obligatory, but pictograms for general escape routing are not. As long as the electrical supply is guaranteed and no smoke has been accumulated under the ceiling, evacuation may be fairly trouble-free. But even under these circumstances it may be difficult to find your way out. Corridors all tend to look the same! We need an escape guidance system that remains functional under all circumstances. Take a look around in your daily environment. It is really something to worry about!

Requirements for escape routing

From the above it will be clear that there is an absolute need for a total passive fire prevention system just as there is for an optimized escape routing system. A bit of mineral wool packed into cable and pipe openings and a occasional sign here and there is not adequate. Taking into account that the floor plan is often not studied, that the lighting may fail shortly after the first alarm and that dense smoke may blot out visibility in corridors, it will be obvious that such an evacuation routing system must have luminescent properties and that it must be installed on the floor or just above the floor against the wall. This is where the lowest temperatures and the most oxygen are maintained for a long time. Something to avoid at any rate is placing life-saving signs at too high a level. An important aspect is in this respect that persons fleeing in panic will by nature tend to direct their vision downwards rather than upwards. They are focussing on the floor to be aware of any obstacles. Furthermore, there should be a kind of “natural logic” system in the placing of symbols and pictograms. Pictograms that are too small, pictograms that are too far away, pictograms that are hardly legible and/or inter-spaced at excessive distances do not make up such a system! The system should be well visible in total darkness, not just for a couple of minutes but for hours. WELL VISIBLE. An adequate escape routing system should work independently of the electrical power. And what is more, the system should be more or less maintenance free. Proof of this can be seen in the number of emergency light failures

due to non-replacement of batteries. Maintenance does not always take place! Another important issue is that higher temperatures may exist in the corridors. To be able to maintain the escape routing functionality as long as possible, the materials used for it should therefore be heat resistant.

What is luminescence?

When the power supply fails, we have to resort to battery-powered sources for lighting purposes (in this context we had better forget about the old-fashioned candle!). The problem with this kind of back-up lighting measures is the size of the system and its maintenance. As a matter of fact, who keeps a flash-light close at hand all the time anyway? And can you be sure the battery isn't flat? For applications of this kind, materials which emit stored energy in the form of light are much more practical. Based on a completely new technology, luminescent pigments have been developed which are capable of storing energy and subsequently emitting light that is clearly visible for many hours. The technical word for this is photo-luminescence, or in consumer language "afterglow" or "glow in the dark". This new technology cannot be compared with the old-fashioned zinc sulphide pigments which emit visible light for a few minutes only. The intensity of light emission of the newly developed pigments is 15-20 times higher than that of the regular pigments. The pigments are "charged" by irradiation with daylight, fluorescent light and light from halogen sources. In darkness, the energy stored in the luminescent pigments is emitted in a wavelength range of 520 nm. The colour of the emitted light is bright green, and therefore clearly visible to the human eye.

Given the current state of the art, a light emission with a value comparable to that of a normal lamp is not feasible. However, by means of appropriate formulation of the material, judicious choice of background, appropriate positioning to ensure sufficient contrast with the surroundings, and adjustment of the size of the emitting object, the visibility limit can be raised to a very acceptable level. Unlike with conventional pigments, the new pigments are oxidized during the manufacturing process so that aging and reduction of light fastness during a service life of at least ten years is excluded.

Light emission

It will be clear that there is a correlation between the light emission of the luminescent material and the visibility distance. How much light emission is needed? The value of luminescence is expressed in millicandelas/m² (mcd/m²). The values set in the norms and regulations are very low. Paragraph 7.2 of the IMO Resolution A.752(18) for instance mentions that "photo-luminescent materials should provide at least 15 mcd/m² measured 10 min after the removal of all external illuminating sources" and "the system should continue to provide luminance values greater than 2 mcd/m² for 60 min." The German DIN sets values of respectively 20 and 2.8 mcd/m². What do these values mean? Several thousand mcd/m² is a luminance value of only 15% of that of a white surface illuminated by a 100 lux lamp. This in itself shows that visibility at 15 mcd/m² will be very poor.

This is a general problem with rules like IMO, DIN, etc: they only set a minimum requirement. We have to be aware that this puts a brake on new high-quality

developments. Who is going to pay more for safety (you don't get the feeling of getting any benefit from it, nor do you get any money on your investment in return) once a cheap product just meets the standards? In a way low standards always lead to cheap, cheaper and cheapest. There is no longer any real need for quality products in the field of safety, because **PEOPLE WANT TO SAVE MONEY AT CONSTRUCTION SITE.** So, the lowest standard wins and human safety is the ultimate loser. It is similar to passive fire prevention: escape route marking is sometimes far from optimal due to ineffective application, the very poor legislation, failing inspection of installed systems, and ignorance of the maintenance needs.
Based on our formula developed to calculate viewing distances at certain light emission levels, the emission should be in the range of at least of 80-100 mcd/m² after 10 minutes and of 15-25 mcd/m² after 60 minutes to guarantee good visibility. And this is substantially more than the minimum requirements in the regulations! Therefore, the regulations should be modified in order to raise the overall safety level!

Legibility

It is a waste of money to invest in escape route marking when the visibility in total darkness is just not sufficient to guide people out of the place because of an ineffective level of light emission. This amounts more or less to "having done what was required". An advantage of the new pigments is that they can be charged in an unlimited way, which means that the longer and more intensively the pigments are irradiated the more energy they will absorb and subsequently emit as light. The result is that, although decrease of light emission will occur in time with these pigments, an effective emission level of at least 15-25 mcd/m² is maintained for many hours.

The light environment is the main factor defining the level to which the pigments will be charged. The lower the amount of lux available for charging, the lower the light emission of the afterglowing materials. Confusing in this respect are the specifications in the norms requiring the use of a so-called Xenon lamp for light measurements, bombarding the luminescent material for 5 minutes with 1000 lux light of a very high UV contents. For ease of understanding: the 1000 lux light produced by a Xenon lamp is equivalent to 10,000 lux light from a video lamp! All this results in claims of super values in brochures and data sheets, exceeding the values set in the norms and regulations many times. These lamps are not used in our daily environment, however. Moreover, they aren't actually used at all. So, is there any guarantee that the material tested in this way will function properly in a daily light environment of 500-700 lux or even lower? To show how values drop substantially at lower light conditions: charging at 500 lux gives 150 mcd/m² after 10 minutes, at 250 lux 125 mcd/m², at 100 lux 90 mcd/m² and at 15 lux only 30 mcd/m². And these figures are all based on the new pigments.

In order to obtain a more objective picture, we have used our formula to calculate the viewing distance of a certain letter size in combination with the values given above. That yields the following result: at 150 mcd/m² a letter 50 mm high can be viewed properly at 10 metres, at 90 mcd/m² it is 8 metres and at 30 mcd/m² it is only 5 metres. To compare these values with the regulations: 15 mcd/m² gives a legibility distance of only 3.5 metres and 2 mcd/m² only 1.3 metres. The ultimate result of this is evident: poorly luminescent objects must either be enlarged or their inter-spacing must be reduced substantially to obtain a reasonable visibility. Appropriate design is the

keyword for escape routing systems, quite clearly! The legibility formula together with a table showing the light emission values under various “charging” conditions is the tool of choice for optimizing the design of the escape route marking system.

Research & development

It must be obvious by now that escape route marking is of vital importance in case a fire occurs. Therefore, in the eventuality of a fire, the carriers of the pigments should have good temperature resistant properties. In this respect paper or plastic stickers are more or less worthless. They will deform or melt at temperatures as low as 60 to 70 °C. When a fire occurs, far higher temperatures are soon reached. Silicone rubbers and compounds capable of resisting brief exposure to temperatures above 300 °C, EPDM rubbers and thermoplastics with peak loads well over 100 °C, and pictograms screen-printed on aluminium are the base materials of choice. These carriers guarantee that the luminescent function will be retained at any rate for the period of time that escape remains possible. The transparency of the base material, the arrangement of the pigments admixed in the carrier, the appropriate dosages and grain sizes of the pigments used, as well as the thickness and size of the end-product will ultimately determine the distance at which the luminescence is sufficiently visible. An innovative method of compounding base materials and pigments has been applied to develop luminescent rubbers and plastics possessing emission values which, even at low environmental light conditions, exceed the levels specified in standards. Silk screen printing technology and manufacture of luminescent silicone putty and paint have also been developed on the basis of this compounding method. World-wide patent rights on this technology have meanwhile been obtained.

The developed base materials have enabled the manufacture of a wide variety of luminescent products from pictograms and low location lighting systems, to rubber bossed tiles and footprints, sheets, cords, tapes and hoses to polycarbonate fluorescent lamp shields. No battery needed anymore to give light day after day after day! Due to the light fastness of the new pigments light emission is retained in the very long run.

Material testing for safety

Luminescent safety measures should not be tested only to the specified method with the Xenon lamp to determine the light emission properties. A range of tests under a wide range of environmental light conditions should be carried out to enable to establish a table of the luminescence values based on practical circumstances. These are the right values for designers to develop an optimized routing in darkness.

In principle, luminescent materials are maintenance free. As long as they get charged they will emit light. At least this is what we think. But what about after several years of service life? Numerous pictograms can be found in installations showing light emission levels that are pretty questionable after just one year. For that reason accelerated aging tests should be required to determine the quality of light emission in the long run. Nowhere is this specified in the norms and regulations, however. In case materials are not aged to give proof of the light emission after many years, for the sake of safety the only alternative is to perform emission measurements at reasonably short intervals at site. Keep in mind that this will cost a substantial amount of money. Will anyone comply without enforcement? The same goes for the UV resistance, and

in certain locations the weathering resistance of the luminescent materials and even resistance to cleaning agents. It all has an impact on the quality of the safety system in the long run.

When materials are used on floors an additional abrasion test should be carried out to determine the lifetime of the material. This is not as important as the previous tests because it can be visually inspected once installed. However, who is going to replace the worn-out materials in time? Crucial tests are the determination of flame spread in case larger objects or larger amounts of the material will be applied in escape routes, and the determination of the toxicity of the smoke released by these materials in case of fire. Flame spread contribution and the release of toxic fumes in case of fire will cause additional problems in escape routes. Think of the use of PVC or polyurethane materials! The creation of dense, toxic fumes - by a safety system?

Mock-up testing for safety

The human factor plays an essential role in the escape from a dangerous environment. We know that once panic breaks out all control is lost. Besides, panic is irrevocable, once it hits it just gets worse and worse. Once panic occurs safety signs will be ignored and most possibly individuals will do nothing but struggle to fight through the crowd. This is something for other disciplines to investigate and find how to get this behaviour under control. Our objective is to prevent panic as long as possible. Passive fire prevention will contribute to this by keeping smoke out, but for certain an optimized escape routing will prevent fear and panic for as long as possible. Regular tests with human subjects should be carried out to determine if the design and the quality of the light emission of the escape route marking is effective.

A new building is under construction where research and development will be combined with a training and education institute for passive fire prevention products and systems and for the improvement of evacuation signposting systems in buildings and on board ships. The center consists of a presentation theatre seating up to 45 persons, and a mock-up covering about 500 square metres in which various evacuation signposting systems are installed to determine their effectiveness in the dark. The behaviour of escaping persons inside the test facility can be recorded from a separate technical area by means of infra-red cameras and an audio-video system. In addition the center comprises three laboratories with a total surface area of about 300 square metres in which, respectively, large-scale fire tests, mechanical tests, and light emission investigations are performed.
Don’t fool yourself that fires always happen to others. Proper escape route marking is not just something that may or may not be required by regulation. Some day you may need it! Why to go for an absolute minimum to save some money. When it comes to money first rather than safety first, personal safety is at stake for sure!

Maintenance required?

Who likes to hear that the light emission of safety signs does not work properly once invested for? Who checks them anyway and what is more, who cares or knows? Of course it is hard to get evidence of this in actual situations because nobody will be proud of non-performance, but how about this one ….? A five-year old ferry was docked last year for its first total overhaul. During this overhaul a surveyor switched

off the lights to check how the low location lighting system performed. Scarcely any light emission visible, he noticed. He called for an independent measurement. Almost 90% of the system failed due to aging and due to the low environmental light situation. For how long has this been the case? Could it be that this ferry had been sailing for several years without an emergency safety system? Zinc sulphide systems only were used, which are known to age quite rapidly. But they are cheap, and they complied with requirements at the time of installation.

This case shows that something has got to be changed. Where are the standards for regular checks? In a new ISO draft it is required that regular visual checks have to be carried out. What does this mean? It is person-dependent and guarantees nothing. On the other hand the costs involved with official measurements at short intervals say every six months - may be substantial. As mentioned before there is only one option: obligatory aging tests on the materials. Beside, a tool has to be developed to do simple measurements to record the performance of the safety system on-site by the safety engineer of a vessel or building. Our R&D Department is already working on this. This could limit the official measurements to perhaps five-year intervals. For the sake of safety: we have to inspect regularly. No doubt about that.

Speed of evacuation in rooms or cabins

As mentioned before, escape route marking should be regarded as a total system, not just a pictogram here and there. Such a system should be an integrated one, and it must start in the rooms or cabins. Once more: the fire bell rings, you wake up and want to switch on the light, get dressed and collect your personal belongings before leaving the room. This can take quite a bit of time if you cannot find the light switches, your clothes or your personal belongings. In hotels, for example, light switches are generally hard to find and not really customer-friendly. All of you may have experienced this when you enter your room in darkness, searching with your hands on the wall to find where the switch is. Think of the scenario where you desperately want to find it in an emergency! By making the switches luminescent or fitting them with luminescent collars, this problem can be solved at no enormous cost. You should train yourself to put your glasses, keys, watch and wallet always in the same place. But who thinks about this after a hard day’s work. You prefer to relax first. Still, a luminescent plate on the night-stand would enable you to find these belongings in darkness pretty quickly. A low-cost solution, too.

Luminescence will not keep you awake as sometimes the LED of a radio or clock will do. It is a soft light that does not shine through your eyelids, so the application of luminescent materials in rooms guarantees at least a certain visibility in darkness. This would make it easier to find your clothes if it comes to an evacuation. More seconds gained in evacuation. You want to call reception. Where is the phone? Its dial plate can easily be made luminescent with tape at minimal cost. More time saved! You realize you did not study the floor plan! You are not the only one. This should be compensated by highlighting the door contour and the door handle, but also by having an SOS indicator on the door. You should know whether to go to the right or to the left, immediately! Of course no owner of a vessel or a hotel likes to have SOS signs around in his installation, but let us not forget that human lives are at stake here!

All these simple measures will help to prevent panic, and the time needed to quit the room in an emergency will be much shorter than without them.

Speed of evacuation in corridors

As soon as you have left the room you need confirmation that the direction indicator in your room was right. By placing these signs at eye-level with proper inter-spacing on the walls, there can be no mistake. Just follow. The advantage of using SOS instead of EXIT is that there can be absolutely no doubt. EXIT signs could lead you to the elevator - not to be used when a fire occurs. Then you are really lost!
It is dark. You have to concentrate on not stumbling because you are running for your life. Fitted with a continuous low location lighting system, with direction arrows just above the floor set against the wall and interrupted by SOS signs, the floor is illuminated so that you can see any obstacles! When you have to crawl because of dense smoke you still have your direction indicator nearby.

A dark corridor is not particularly inviting. Making the lamp shields luminescent will always provide some emergency lighting when the power fails. As long as the corridor is not filled with smoke this will help you tremendously to find your way out. It is even better to install small lamps with luminescent shields about 300 mm above the floor but recessed in the walls (not in front of the wall because we don't need any extra obstacles) at regular intervals. These lamps will guarantee emergency lighting for a long time, even when smoke is entering the corridors. Special impact-proof, luminescent shields made of polycarbonate have been developed to prevent these lamps from being damaged. Altogether there should be enough light now to escape fast enough. The emergency door should be made clearly recognizable. Who likes to open a door not knowing what is behind it once you are in the middle of a disaster? The contour of these doors should be made luminescent. By placing an SOS pictogram on the door there can be no doubt that THIS is the emergency exit! By placing luminescent floor tiles in front of the door, the door will be visible from a larger distance. Besides, light invites you to approach. One final improvement could be to fix luminescent footprints on the floor leading the way to the emergency exit. All this shows that speed of evacuation can be improved substantially by simple means.

What is less functional?

The following systems have low or zero functionality for the purpose of effective escape route signposting:

* LLL systems based on glowing LEDs in the floor, because:
  a) these systems are electricity-dependent, and
  b) they do not give a really clear indication of the direction of escape.

* pictograms and/or arrows set above eye-level. When people are trying to escape, they will normally tend to look downwards rather than upwards. If they have to look upwards, it is quite possible that they will not notice obstacles in their path and consequently trip up. People coming up behind will fall over them in turn. What is more, if smoke is present the highest signs will be the first to be lost to view.

* luminescent LLL systems not provided with arrows or the SOS sign, because:
  a) the LLL system has no functionality at all under normal lighting conditions, and
  b) people will try to find their bearings by means of the EXIT signs, and therefore in all probability end up at an elevator.

* luminescent systems whose light emission has fallen in a short time to such a low level that it can hardly be said to perform a secondary lighting function or be visible from some distance.

Certificates

Are there any particular requirements regarding the number and location of pictograms indicating the way out in an emergency or to the muster stations in vessels? Focusing on the shipbuilding market we found in SOLAS 1996 Amendments Chapter III, Regulation 11.5: "In addition to and as part of the marking required under regulation II-/28.1.10, routes to muster stations shall be indicated with the muster station symbol, intended for that purpose, in accordance with the recommendations of the Organization (recommendations are as per IMO Resolution A.760(18) as amended by MSC.82(70)". The IMO Resolution "urges governments to ensure that …" and furthermore list the symbols. That's it.
The regulation II-2/28.1.10 is the requirement for Low Location Lighting and IMO symbols. The symbols are listed in the IMO Resolution A.760(18). The regulation for Low Location Lighting systems is IMO Resolution A.752(18). IMO Resolution A.752(18) states in paragraph 6 that "all escape route signs and fire equipment location marking should be of photo-luminescent material or marked by lighting and fitted in the lower 300 mm of the bulkhead" and "low location exit signs should be provided at all exits". How about the fact that these exits may be 10 metres or even more away from where you are? Any thoughts about how to reach these far-away exits in total darkness? It may even be impossible to recognize the pictograms under normal lighting conditions. In practice the classification societies only stamp for approval the submitted drawings showing the exits to the muster stations, in a way leaving it to the yard or the owner to decide on the number of and locations where the signposting pictograms are going to be installed.

The requirements for application of the Low Location Lighting system are specified in a bit more detail. Unfortunately, however, the light emission values required in the Resolution are very low. Paragraph 7.2 mentions that "photo-luminescent materials should provide at least 15 mcd/m² measured 10 min after the removal of all external illuminating sources" and "the system should continue to provide luminance values greater than 2 mcd/m² for 60 min."
Based on the formula we have developed for calculating viewing distances of luminescent signs, a letter height of 50 mm at 15 mcd/m² is legible at a maximum distance of about only 3 metres and at 2 mcd/m² not even at 1.5 metres. What kind of inter-spacing would be needed with these values! Nothing is specified about inter-spacing, nothing is mentioned about legibility! And never forget: luminescence may be your last chance to escape!

Conclusion

The advantage of luminescent materials is that these type of materials are independent of the electrical system and may in principle be regarded as maintenance free. But what about the aging process? What about the environmental light conditions, which might change dramatically during the service life of an installation? Nobody asks, but for the sake of safety it must be asked. We know that batteries of emergency systems in installations are often flat and scarcely ever checked. The majority will not work properly when it comes to the point. Would this be any different with luminescent materials? We just don't take the time for this kind of issue. On the other hand, investing in all kinds of tests to prove that there is no aging and that charging will be measured in the lowest light conditions, etc. does not pay off, because "this system is more expensive than …". In other words, in many cases it is money first rather than safety first! We need stricter regulations to rule out the use of poorly functional systems, and soon. Keep in mind that a fire in a plane is a worse case scenario and possibly leaves us no chance of survival, but fires on a ship or in a tunnel are the next-worse events which may become catastrophic in terms of escape. **Something to worry about!**

Passive fire prevention and luminescent escape route marking systems are a vital necessity in buildings and on board passenger vessels. Let us not underestimate the importance of these safety measures!
On the basis of the new luminescent pigments, under the product name YFESTOS (the name of the god of fire in Greek mythology) BEELE Engineering has developed a range of products for additional safety in our daily environment. All the same, we urgently advise you to study floor plans in the future, and you should also test-walk the route to the exit and print it indelibly in your mind whenever you enter an unfamiliar building. By also carrying out a "creative safety audit" of your own specific living and working environment you will also surely find out for yourself that that luminescent materials can potentially play a literally life-saving role in many places.

Biography

Mr. J.A. Beele is president of BEELE Engineering bv and CSD International bv (Aalten, the Netherlands). Mr. Beele has over over thirty years of experience in the development and production of systems for passive fire prevention. Among these systems are the RISE system for ducting of multiple cables and (excentric) pipes and the YFESTOS range of luminescent products which play a valuable role in marking advised routes to walk or for example highlighting electrical equipment.