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New Technology Debate - Lighting Systems

Bob Horner	Osram
Ian MacDonald	Underwater Lights USA

Chairman—Martin Redmayne

[Thump thump—sorry Ted!!]

Allright, can we settle down please, for the very, very final session of the 3-day serious stuff; the fun starts tomorrow. As you've read, this is the Lighting Systems Technology Debate—we've reported huge amounts in The Yacht Report about LED, HID and all the various lighting technologies, interesting debates in the magazine, on the forums, and it seems to be a grey area in some people's world. Foggy, unclear—

Tork

Dim?

Martin

Yes, even dim. A recent boat I was on in Sardinia with Tork, a large Perini Navi, and it had something like 180 halogen downlighters, wonderful design, incredible heat output, so much so that when they turned everything on, on first delivery, literally a cloud of black dust fell from the lights as they burned all the black paint off. These are some of the typical problems you have in the lighting industry—or the painting industry!—so these two gentlemen to my right—one is a buffoon *[but you don't even know me yet!!]* —one is a lighting manufacturer, essentially a guy that knows what he's talking about when it comes to the yacht market. However, Bob is a lighting expert from Osram, one of the world's largest lighting companies with some very clear intelligence coming your way. Bob, are you going to start off? Thank you.

Bob Horner Osram

Well, good afternoon, and almost good evening. This is one of my first exposures to a group such as this and it was nice getting to meet some of you and getting to know you and listen to some of you speak. When I first spoke to someone here, they had a British accent and I said 'hmm, that's interesting, some foreigner is here'. Well, it turns out, on speaking to more of you, I'm the guy with an accent! I'm in the minority here, it seems. But I hope you'll put up with me for now. And looking at some of the posters and all the pictures and the beautiful boats out in the yard there, I guess when I go back to my 20foot Boston whaler back home, I'll feel pretty timid. I'll have to upgrade I think, pretty soon. I should get started because we're the only thing between this good audience and the barbecue. So I won't belabour any more issues, I'll get started with the presentation. One thing I wanted to mention before we start—Osram, some of you, most people here I guess, know Osram. Who has not heard of an Osram here? One quick thing—when you're here in the States, you'll

notice that you don't see Osram very much. We go to market in the States under the Osram brand for this specialised application, but you'll see Sylvania is the brand Osram uses in the U.S. So they're both the same company in the U.S. And one of the things you should also know is that we're a full line manufacturer, and I don't mean to make this a commercial statement as much as a statement of objectivity, such that we make all the different types of lighting and lamps and I think that lends itself to a bit more objectivity on our part since we make everything from halogen right on up to the newest LEDs. So, with that said, let's get started.

OK. We're going to cover the main light sources. I will not in any way belabour each one at length because I think a lot of you know this already, plus we don't have time, so I'll make it the high points of each one and then we'll take questions later on. I also have some demo equipment and if you'd like to come up later after the presentation and take a look at something a little closer, feel free to do so.

So let's start out with the 130- or 140-year old light source, the incandescent and halogen. These are both filament lamps, and the difference between them to a lighting engineer is sort of major but to many people they're both very similar. So they're both filament lamps, they both produce light by the old way of heating up a tungsten filament but halogen, because of a special construction and higher pressure and halogen gases inside the bulb, have a longer life than incandescent. So that's their main attribute. They also produce of course—incandescent halogen has a wide variety of types, after all these years, I'm sure we've covered about every application that can be addressed with these lamps. They've got a pleasing colour. That's the one thing that's been a mainstay, and it's actually been something that, even in the latest LED technology, we've all been trying to duplicate, whether we like it or not, we all grew up and lived for the most part under incandescent lighting. So we all try to duplicate that pleasing warm colour when we address the market with different technologies. They are dimmable, which is a nice thing, not all sources are dimmable, and not all sources that retrofit into an incandescent socket are dimmable, so you need to be careful of that. These are internal, of course. Here's the trick, as Martin mentioned before. Lots of heat, low efficiency. The lowest efficiency light source. And they do have a relatively short life measured in a few thousand hours and in some cases even less. These are the various halogen lamp types—by no means comprehensive but the nice thing about halogen is that they're very tiny and if you can see, I'm holding one right here. You can barely see it. But this is typical of what makes halogen a nice source relative to regular incandescent— it's a smaller size and can fit into a much smaller fixture, the reflector can be more efficient, you get more light out of it, so halogen is definitely a preferred filament light source. Where's halogen used? Most of you, I think, can answer this. Just look around. Any interior space, cabins, living space, dining areas, entertainment areas, any place on a boat or ship that needs light can be serviced by halogen or incandescent. On the exterior of course marker lights, railing lights, bollards, what have you. Underwater lights also, under the hull, can use halogen or incandescent. And diving lights for those of you who like to dive. I'm sure you have some search lights or whatever that use this source.

So, enough on that, I'm sure we're all pretty much aware of what those sources can do. On to fluorescent. Fluorescent lamps use a different type of technology called gas discharge. And this is called a low-pressure discharge as opposed to HID lighting, which many of you are probably familiar with—a high intensity discharge. Low pressure discharge means that the pressure inside a fluorescent lamp is below atmospheric pressure. It's about 1/100th of an atmosphere. And we need to do that because the mercury inside—(*oops, I used that word, 'mercury'*) —fluorescent lamps

do use mercury and I guess these days mercury is maybe not such a good word but it really is good stuff because it is a very efficient radiator of ultra violet and when fluorescent lamps are operating—the way they operate is that the arc discharge excites the mercury, the mercury gives off U.V. Now, we don't want to use any U.V., we don't want to have U.V. coming out of the lamp, so what we do is the lamp is coated with a white powder, a phosphor, and that phosphor is sensitive to U.V. and when the U.V. bombards the phosphor it changes the energy from U.V. to visible light. So that's the job of phosphor. It extends the wavelength, and extends it into the light spectrum that we can see. The nice thing about fluorescent also is that it's very versatile because these phosphors can be changed to give you different types of colour. How many of you remember the old days when fluorescent used to be this terrible blueish or greenish light? Most people still maybe have that impression. However, about 10-15 years ago, much better phosphors were developed, which made this lamp a much more pleasing colour. And one of the things we've come up with is a warmer phosphor, which can almost, not quite, duplicate the warmth of a halogen lamp. Fluorescent lamps. What else. Very efficient. These lamps are probably about—oh, some systems are ten times more efficient than the filament sources of incandescent halogen. If you want numbers, these systems can have efficiencies or efficacies as we call it, of about 100-110 lumens per watt. Compared to incandescent, at about 10 or so. Again, they have a good colour, no more blueish cast, you can get different types of colour effects with them. They have a smaller diameter—these lamps now come in diameters of about ½" or 5/8". Or about 15mm. So they can be used in spaces that are smaller, tighter, and more pleasing from an architectural standpoint. They're dimmable—fluorescent lamps are dimmable, contrary to what some people may believe. They do need special controls to make them dimmable, but none the less they can be dimmed, and if the control is a good one—there are also ones on the market that are not so good—but the good ones will not affect lamp life. You don't increase lamp life—some of you may know that, when you dim an incandescent lamp, you increase its life dramatically. If you dim an incandescent lamp or halogen lamp just 10%, meaning say from 120 volts down to 100 volts or 110 volts, you can double and triple the life of the lamp. But not so with fluorescent. Fluorescent you can dim, but it doesn't do anything for the life. It doesn't hurt it, but it doesn't help it. They come in a variety of sizes and lengths as we know from 8"-10" long up to 8 feet long, actually. And with electronic control gear these days there's no humming, no flicker at all, they are very, very efficient and accommodating systems these days. Life is up to 20,000 hours, perhaps more, depending upon how you burn them. If you don't turn them on and off too often, you can get even 30,000 hours out of some systems. The only drawback of course is that these systems cost more, so obviously, when you start adding control gear and dimming gear and the like, it can cost a lot more. For example, the recessed downlights—these high hats, like you see here—an incandescent or halogen downlight might cost $40—is that like £20 these days, I think? If that were fluorescent, if you had a commercial grade fluorescent fixture with dimming controls and all that, the fixture could cost $200. So, again, it's a matter of making the right selection for the right application. Sometimes, it's worth it. There are restrictions of course, compared to incandescent, when you're talking about designing a system. If you've got someone that knows lighting design, that's doing a design for a particular application, they are restricted because of the size, of fluorescent, they don't fit everywhere, of course. And this is what some of these lamp types look like. Here you have the typically compact fluorescent lamp—this is the small one here that is 15mm or 5/8" in diameter. These are the new technology fluorescents, here's the original compact fluorescent lamp with the twin tubes here, and these are the newer ones with triple, with three sets of twin tubes. So you can get these in wattages up to about 70 or 80 watts. And they can give you as much light as about a 300-watt

incandescent lamp. So again, in that case, these can be very versatile. Where are they used? Well, mostly cove lighting, recessed downlights, the compact fluorescents for recessed downlights, and under cabinet lighting also for fluorescent, but of course they're shorter and thinner.

Xenon. How many here know about Xenon lamps? A few hands coming up. These are pretty interesting. They're a discharge lamp but they're a high intensity discharge lamp, they're a high pressure lamp—in fact some of the larger wattage types are dangerous and when you go to see a movie, I think all of you have probably been to a multiplex movie—when you're watching that movie, a Xenon lamp is what is inside the projector projecting the film on the screen. Now there the lamps are about 3000 watts or 4000 watts, so they're quite powerful, they also cost about $2,000-$3,000 and they only last about 500 hours. But none the less, the unique characteristics of Xenon are important. Why Xenon? Well, the Xenon discharge is a simple discharge, it's just Xenon gas inside a bubble of glass, but the nice thing about it is, it gives a very, very smooth colour spectrum. It gives you a lot of the colours equally well. So you get good reds, good greens, good blues and all the colours in between. There are no filaments, it's a discharge lamp, so very rugged. You do need control gear to start and operate these lamps, just like you do for any discharge lamp. Usually, Xenon lamps need about 20,000 volts to get them started, so quite a lot higher. When you have a fluorescent lamp, it takes about 200 or 300 volts to get it started. So the control gear for these is a little bit more elaborate and a little bit more expensive. The interesting thing here too is the efficiency, even though it's a discharge lamp, and usually discharge lamps are much more efficient than incandescent or filament lamps—but this is a special case. Xenon has only about the same efficiency as incandescent. So it's about 12-20 lumens per watt. So not very good. So why do we use them? Well, we use them for the colour, and we also use them for another reason. They are instant on, they have good colour, but the arc of a Xenon lamp—now go back to fluorescent. If you have a 4-foot fluorescent lamp, the arc is almost 4 feet long. You really can't focus that, it's just giving you a blob of light. Even if you look at halogen lamps, or filament lamps, with that tiny filament—the filament is still about 4mm or 5mm or 6mm long, for the smaller wattage types— in the high wattage types, the filaments are very long. You really can't do a lot with that, and again, it's sort of a blob of light that you're trying to control. A Xenon lamp has a very, very tiny arc gap, or arc length, as we call it. Somewhere in the order 0.8mm, so it's in the English system about 1/32". I should say the American system. If you're taking all the light that that produces and putting it into such a tiny space, the brightness of that tiny point of light is equal to the sun. And because of that, you can design very, very efficient reflectors to take advantage of that. Now, some of you, if you know Xenon, you know there are searchlights and there are portable searchlights you can use on a boat, on a ship, handheld, there are also stationary types. But because the reflector is so efficient, you could have a fixture—I'll show you one in a minute—a handheld with a 75watt Xenon lamp like this one I'm holding here. And again, if you're interested, you can come up later and take a look at it—it has a plastic shroud around it because this again has a high pressure, so we try to protect the people handling this. This is a 75-watt lamp, in the proper searchlight, in the proper reflector, it can shine a beam for a mile. So again, very precise, and it's all because that arc gap is so short, and you really have a point source of light in order to control. So what do these look like? These are what Xenon lamps look like. The one on the left here is the one I just showed you. Here's one that was put into a reflector. Now, sometimes, the lamp manufacturers will put these into the reflector, and sometimes the fixture manufacturer will take a bare lamp and put it in their own reflector. So it all depends on the application. This is one that I talked about earlier. The one that’s used in the movie theatres, I thought you might be interested to see

what they look like. Again, very high wattage, 3,000 to 4,000 watts. These are available up to about 8,000-9,000watts. How many have been to the Luxor Hotel in Las Vegas? In the Luxor you can see a searchlight, a beam of light coming out of the peak of the pyramid. Well, that's a 7,000-watt lamp just like this, producing that ray of light coming out of the top of the Luxor, shining into the heavens there. Where are they used? Well, mainly outdoor floodlighting, although not as much, again they're used mainly when you need precise beam control. Searchlights, fixed and portable. Diving lights—pretty popular for these lower wattage types. Here's a picture of one of the more high-performance Xenon searchlights available on the market. Again, you can see how this one happens to be portable—it has a battery pack, you can handhold this, it's about 4lbs-5lbs, still a nice unit. Very precise reflector—this is the one that shoots about a mile. And another interesting application that you may be interested in, those of you that are afraid of any pirates in the Caribbean may want to take a look at this application. If you want to mount one of these on your boat or ship, feel free to do so. You can have a nice Xenon searchlight picking out the enemy.

OK, next. Another discharge source. This is one of the more common HID sources, metal halide. There are actually 3 or 4 members of the HID family, straight mercury lamps, there are metal halide, there is something called high-pressure sodium, and also low-pressure sodium, but I just thought we'd concentrate more on metal halide today because that's a very popular one for marine applications. It's a discharge light source. There are little differences in the construction here that make this unique. These metal halide lamps have a cocktail inside the glass tube—it's an exotic mixture of various metals. There is mercury in these; most metal halide lamps have mercury in them as a base metal but then they add things, almost like making one of the fancy drinks we have these days. There are metals added like sodium and scandium and dysprosium and all sorts of exotic elements from the periodic table. And with the right mixture, you can create a different type of light. If you want warmer, you can create warm. You can create a light that's almost as warm as incandescent halogen, you can go cool and create light that has a cool colour like Xenon—again for those of you into the numbers, Xenon colour temperatures are around 6,000° Kelvin, that's the way we measure colour. We call 6,000° cool and we call 3,000° Kelvin warm. I still haven't figured that out, it's just something you have to remember. It seems opposite to what you'd think. But the cool colours can be produced, or the warm colours, with metal halide, but not so with these other lamps. So a very versatile source. And it can have good colour rendition—the old style metal halides that you see on the street—I shouldn't say old, I mean older types, when you're driving along in a street you may see the white light for street lighting, that's typically metal halide. The colour is OK, it has what we call a Colour Rendering Index—somewhere around 65 to 75, which means it's about—75% is good, a colour is incandescent, we use that as the base again, we grew up under it so that's the base that we use. But you can have metal halides as high as 90 CRI, or even higher. They're not instant on. They take some warm-up time, typically about a minute. So you don't use this in a space where you need light right away. It's something that you might use for outdoor lighting, where you can turn it on at dusk and it can have a little time to warm up, or where it's not urgent to have the light immediately. Again, you need control gear, it's a discharge source. But there are some new types of control gear—in the old days, you used to have this very big, clunky transformer type of —we call it a ballast is the standard name for this control gear—but these days we can have electronics do some of the work for us. And we can have electronic control gear that's quite small and compact. This happens to be one for a 39-watt metal halide lamp. Whereas if you would use some of the old technology, this ballast would probably be about this big and weight about 12 lbs. So quite a big advance in this area. It has good energy efficiency—the lumens per watt for metal halide can be as high as 100-120 lumens per watt. Even

eclipsing some of the good fluorescent systems. So again, very good energy efficiency with metal halide. I think you'll see that of all the sources we've spoken about so far, this one does have in total probably the most versatility and the best combination of factors that you might want to use these days. A wide variety of lamp types. This is not a new technology in essence; metal halide has been around since the 1950s, it has been greatly improved over the years though, and there are a lot of different fixture types, for underwater, as you'll see in a minute. Wattage range—20 watts up to 1200 watts, so you're getting a wide variety of types for different applications. It is more expensive than halogen or fluorescent though, so you need to apply this properly and where it's needed. Life is good. That's a good statement in general! Up to 15,000 hours. Again, it could go longer but that's about the useful life. Now, one of the interesting things with metal halide though is over time, metal halide will colour shift. It starts out nice and white, and as it ages it starts to get possibly a little bit greener or possibly a little bit on the magenta side, and that's an indicator that the lamp is ageing and should be changed soon. Because you don't want to have—for the one part, the colour is getting worse, and on the other hand you're not getting as much light, and you're paying for light you're not getting, you're paying for the same power the lamp is using, so the lamp is still using maybe 200 watts but it's not giving you all the lumens you used to get when it was new. So it's a good idea to change it and get the light you're paying for, with the energy. Metal halide lamps come in a myriad of shapes and sizes. This is what one of the standard ones looks like, this is on the middle picture there, up in the centre. So nice and small, compact, you can make some very nice fixtures with these, they don't take up a lot of room, and again the arc is fairly small so you can get some pretty precise beam control and pretty precise light patterns with these. And one of the newer types that you might be interested in knowing about is this. You can now get metal halide in a little par configuration like you used to have halogen lamps. Some of you may have seen halogen lamps like this, this is a par 20, meaning it's 1/28" in diameter. But this is a metal halide lamp, so it gives you about 5 times the amount of light you get out of this halogen equivalent. So again, very interesting new technology, even in the older metal halide family. Where do we use them? Where is the best place to use them? Well, again, exterior floodlighting, underwater lighting, and entertainment lighting. Those of you who own a yacht big enough to have an entertainment area or a dance floor or a disco, you probably might be able to put some metal halide lights in there. If you've been to any nightclubs lately or discos, you know the fixtures where the heads are moving around and scanning around the audience in different colours, those are all metal halide fixtures with various types of coloured filters that can produce the different colours, but they start out with a good colour white light. So that's why they're pretty versatile and can be used in those applications. OK. That's about it on the more traditional light sources.

Now we're going to go on to something that I guess is the buzzword nowadays. Solid state lighting, LEDs. I guess I'm not the first one to say this—this is the next big thing in lighting. The original light bulb was invented by Thomas Edison in 1879 and there wasn't really anything of a major breakthrough until about 1939, when the fluorescent lamp came along, which was the first commercially viable discharge source, introduced at the 1939 New York World's Fair. And since then, there have been variations of that, then high intensity discharge came along in the 50s, but again, it was all variations on a theme. They were all more or less mechanically made and they needed large manufacturing machinery, so nothing was really that different until about—well, LEDs were invented back in the 50s also, but they were used mainly in instrumentation as indicator lamps, some of you may have had some cars back in the 80s that had a little indicator light on the dashboard, a red or yellow, or green one that was an LED but they were used mainly in that capacity for an indicator. You

wanted to look at it to see a certain colour, or to see if something was on or off, or if your engine was about to explode, or whatever.

Nowadays, recently, in about the 90s, a breakthrough even in LEDs was made and everyone wanted the holy grail of LEDs, which was the white LED. How do we take an LED and instead of having a red or yellow one or whatever, how do we produce a white LED? Well, it turns out you can't. There is really no such thing as a white LED. Many of you may have seen white light coming out of LEDs but it really isn't the LED itself. To produce a white light with an LED you need to take a blue LED and put a yellow phosphor, like we use in fluorescent lamps—you schmear (that's a technical term, schmear!) some yellow phosphor on this blue LED and voilà, you produce white light. So that's the way white light is produced by LEDs. There's another way to produce it, which is by using a red, a green and a blue LED in combination. However, it's not that efficient. So the nice thing is with red, green and blue, you put them all on at the same time and you can then produce white light, but the efficiency is about half of what you get out of a blue LED with the phosphor coating producing the white light in that manner. The other nice thing about it is you can still produce warm and cool, just like you can with fluorescent or metal halide, you can have a little bit warmer phosphor, a little cooler, so you can produce LEDs with 3000° Kelvin warm light, just like incandescent, or 6000°, that's cooler, like Xenon or like metal halide. Again, this is solid state lighting. It's just a little chip, no filaments, no electrodes, no discharge. But there is something left over, which I'll talk about in a minute. You do need control gear. Now, you don't need anything as fancy as you do with a discharge lamp but you do need some kind of power supply for the LEDs. But it's a lot simpler, so it's not something that—I guess there's some sort of magic in the way these ballasts are produced for the HID lamps, but not here. This is more or less a simple power supply that can be used to drive one, two, or dozens of LEDs at once. They're instant on—in fact, they're very instant on. They're extremely fast in turning on. One of the latest applications of LEDs is in televisions—some of you may have seen, if you're in the market for televisions—Samsung produces a rear projection television that uses LEDs as the light source rather than a high intensity discharge lamp, like most of them. And the LEDs can turn on and off fast enough to produce that picture on your television without any blur or any problems. So LEDs can be modulated and turned on and off very quickly. The efficiency though is still not as high as we'd like—it is between incandescent and fluorescent. Meaning these white LEDs you might read these press releases about, 100 lumens per watt LEDs, they really aren't there yet for mass production but it's coming. Right now, you could expect for white LEDs to be somewhere between 50 and 75 lumens per watt. So it's still not too bad, better than incandescent or halogen.

Colour changing—well, this is a pretty neat kind of thing. If you're into decorating, you're into fancy effects, LEDs obviously can produce colour change. Now, you wouldn't use this white LED—because that is stuck being blue with the phosphor, it's only white. If you go back to the red, green, blue type of concept of 3 little LEDs together, you can now power them at different levels and produce different colours. If you'll bear with me for one second, I'll show you what that looks like. So you can produce some nice little effects—I mean, you can probably think of some uses for this type of display—you're supposed to go 'oooh, aaah'. OK. Again, you can take a look at this a little closer later on and see what these really look like in this array. But pretty neat things you can do with this.

So LEDs are pretty small too, and they come in such an amazing array of shapes and sizes you can do a lot with them, so it's almost the sky is the limit with the kind of design that fixture companies and application people can come up with. One other

thing I'd like to show you is why is the white LED here? You might want to be careful, you're not supposed to look at this but I think you're far enough away. It'll give you an idea what kind of intensity an LED can have. Oops. So in order to show you, oh, I'm blinded here. This is one LED that gives 1000 lumens, it's about the same light as you'd get from a 20- or 25-watt halogen lamp. So pretty bright. They come in different types, if you'd like to come up later, you can take a look.

LEDs have long life. Everybody hears numbers like 50,000, 100,000 hours. Well, that's true in some cases. When you're talking about LED life, there's a question you need to ask, and that is—what kind of thermal or temperature conditions are there? Because LEDs, as good as they are, are very, very temperature-sensitive. Whereas traditional lighting, like HID lamps or incandescent lamps, they don't care. They love the heat. Well, LEDs hate heat. So it's extremely important to make sure that, if you're going to use an LED in some kind of fixture, make sure the fixture manufacturer knows what they're doing, because a cheap fixture is just that. It could give you a lot shorter life than you're supposed to get out of LEDs.

One of the issues also with LEDs has to do with the varying life of the different colours. Red LEDs can last 100,000 hours. Blue LEDs may only last 20,000. The life varies with the colour. A very interesting thing. So if you've got a red, green and blue LED to produce white light and you want to use this for many hours, after a while that blue LED is going to fade out faster than the red and you're going to have to readjust your colours to give you the effect you had when it was new. So again, a lot of caveats here; this is a new light source, we're all learning about how to apply it and how it's used, and some of the precautions we have to take.

Like I said, LEDs don't like heat. I guess we've all heard—someone talks to you about LEDs—well, there's no heat, you don't feel any heat on you. That's true. The heat doesn't come out the front. But the heat comes out the back. Now, that's a good thing in a way because you don't get the heat on the object being illuminated but at the same time, now you have to have some bulky heat sinks in the back of the lamp. So there is a trade off, you have to be careful about how to heat sink it, how big it has to be, sometimes you need fan cooling if you've got some real high output applications. And of course, these are still pretty expensive. So you have to use a little bit of care about where you use them, again, be careful—if you're looking at an LED fixture and the price seems to good to be true, it probably is. And it probably won't give you the performance you expect. And at this point, they're not for high output applications. You wouldn't use an LED in a searchlight. You wouldn't use it in a floodlight trying to flood a large deck on a ship or a tennis court. We're not there yet, not nearly there. So these are some of the various types of LEDs. The one I just flashed in your face was this one here, that's the one that has 6 little chips, right here. Each one of those 6 chips is 1mm X 1mm. So really tiny, but lots of intensity. And this is one that's used in an array—there's two greens, one red and one blue—and this is what's used as a backlight for LCD flatscreen TVs. Sony has an LCD flatscreen out there that's a 79" beautiful television that uses LEDs for the backlight. It also costs about $25,000, so a little bit higher than the normal flat panel. But again, those prices will come down, I think LEDs will be used more and more in flat panel backlighting applications. This is one that has a red, green and blue, you can't see it so well here, that's a low-res shot. But this has a red, a green and blue in one little pod so you can create white light here with this one LED. Or you can create colours, mix them any way you want. This is a little LED group of pods where again, these can change colour, you can programme these to have some on, some off, there's such a lot of different things you can do, use your imagination for, with these.

Where are they used? Well, I hate to say it, but almost anywhere. Again, you have to be careful, you don't want to overuse these, or over-extend their application. There's still a lot of use for metal halide in a lot of applications. There's still a good use for Xenon. And in some cases, there's still a good use for halogen. So you have to select your light source wisely, and don't get overly enthusiastic about LEDs right now. Here are some other applications of LEDs. This is a little task light—this happens to be a medical task light but it can be used for reading lights, or lights above your bed for night time reading—this is a fixture—Ian, I think you know this one—an underwater light for a ship, and this is a wing tip light for personal aircraft. This is the nav light on the wingtip here, with the red or green and then the flasher on the side and a white light in the back. This could easily be adapted to navigation lights on a ship. Again, some more applications where you can see more LEDs being used. Cabin lighting on aircraft, decorative lighting on a bridge, colour sticks, accent lighting, sign lighting here for the colouring, step lighting, again, lots and lots of applications. But here's the bottom line. LEDs are not going to replace every traditional light source. At least not yet. Maybe, in 20 or 30 years, we'll have advanced the technology enough. But not now. But there are a lot of applications where LEDs can be used, a lot of fixtures, a lot of fixture manufacturers using LEDs. I don't think I can visit a customer—I visit different types of customer in our business—medical, marine, semi-conductor manufacturers, entertainment, and I can't visit a customer nowadays without them asking me about LEDs. It's on everybody's mind.

So, what's next? What's coming in incandescent halogen? What's happening? Well, standard incandescent is going away. Legislation was just passed—the latest energy policy Act from Congress passed late last year will ban the use of certain standard incandescent lamps. Starting in 2012, the 100-watt, nice little lamp we've known, to screw into those sockets at home or wherever, is going to be banned. We will no longer be able to make 100-watt incandescent lamps. The next year, the 75s, then the 60s, will go also. So we're trying to phase out the old technology, and even though it was being phased out—I think a lot a people are into energy efficient lighting and have replaced incandescent with compact fluorescent, but I guess Congress felt it wasn't fast enough. So you're going to see some changes. And there may be a good black market for incandescent lamps at that time!

Halogen? This will probably replace a lot of the incandescent because halogen will still be a legal lamp to sell.

Fluorescent? Again, more fixtures use linear and compact—you see more and more with this new thinner fluorescent lamp, the 15-mm lamp, you're going to see a lot more decorative fixtures—cove lighting in particular and for under cabinets.

Xenon? Xenon is where it is. I mean, there's not a lot going on there, there's not a lot of new technology in the Xenon field, it's just a matter of expanding the applications it's in now to a certain extent, but again, because it's mainly for searchlights and for very specific focussed lighting, you're not going to see a lot of new technology there.

Metal halide? Different story. There's a new ceramic material being used—the arc tube inside there, the part that holds that fancy cocktail admitting the light, that's now being shifted over to ceramic, rather than quartz glass. And the ceramic creates a very, very nice atmosphere for the metals in there that are radiating the light. So this new ceramic type of metal halide is extremely efficient, a good colour, it reduces the colour shift we talked about over life, you don't get the ageing effect you do with the standard metal halide lamps, so if you're looking at metal halide, try to ask for

ceramic because that's the latest technology. It's better in every way—it might be slightly more expensive but not much.

So what's next in LEDs? Well, not really much to say here, except there's going to be a lot more fixture types, a lot more LED applications. One of the interesting things with LEDs is that there are certain things right now where you can't put traditional light fixtures. So with LEDs, you may even find places where you couldn't put a light fixture before, you can now do that, because of their size and their nature—they are lower amp applications, they are pretty cool, so they don't need heat sinks for certain applications. You may get a little creative and find that you can put lighting where you didn't have it before. But one of the main things that will happen, I think, especially for marine applications, is in decorative lighting. The colour changing aspect—most people just say 'hey, that's cool'. They love it, they love having effects on the ceiling with colour changes—you even see it now in limousines—if you've been in a stretch limousine over the last few years, a lot of them have the whole roof of the car full of colour changing LEDs. It's pretty interesting. It's not my cup of tea but some people may like it.

You're going to see more use of energy efficient lighting in general. Why? Well, it saves fuel. So, with fuel costs, even if you've got a yacht or a large boat, there's still concern over fuel costs—so this will save fuel if you can put more energy efficient lighting on your craft or in your home. It reduces the environmental impact—again, by saving fuel, you reduce your carbon footprint. There's less energy being generated so, overall, we really gain by this. And one of the key things also is reduced maintenance. The newer lamp types, whether they be ceramic metal halide or the newer fluorescents and of course LEDs, longer life means less maintenance. Which means cost savings, convenience—I was speaking to someone today about the linear lighting on stairwells and stair banisters and the old Tivoli incandescent strip that used these—what they call festoon lamps, they had little double incandescents—well, they burn out after 500 hours or so. Those are being replaced with a Tivoli LED system. So again, a lot of it has to do with not just the look, but the maintenance.

I hope that covered a lot in a short time—I had to gloss over a few things but I appreciate your listening, and thank you very much. I'll be glad to entertain questions maybe later. And I have some other things to demo if you're interested later on. Thank you very much.

Martin

Thank you. Now we'll listen to Ian and some other demonstrations on marine application.

Ian MacDonald Underwater Lights USA

Just before I start, I just want to clarify something. Before I set off to come over here, I received a document from The Yacht Report and a list of rules and regulations on how to behave at the podium. And one of the rules was that there's no self promotion. So it kind of set me back a little bit, so I decided to randomly select a company to illustrate what I'm talking about. And as luck would have it, we're it.

What I'm going to try and do is show how we utilise some of the technologies that Bob has just been talking about. And you can see we use HID, metal halide, Xenon, halogen, LEDs and these provide for underwater lighting—we use metal halide

mainly for the big yachts, Xenon for the intermediate and the LEDs for the smaller vessels. Step, accent lighting, spot, floodlighting, as Bob was telling us—we use the Xenon and metal halide for that. And then, custom lighting. So then, we go on to illustrate HID—these are two underwater lights that we use on the megayachts, one steel and one aluminium, they weld into the hull. These are metal halide, they come with a ballast and some of the results can be seen here on a couple of yachts. Obviously, these are fairly well known boats—these are 150-watt metal halide underwater lights. Interestingly enough, we use the same technology here as Bob said—these are for spotlights or in this case, the fixtures on the right hand side—you can see the fixture, and then Trinity have adapted that fixture into a housing as a spotlight or floodlight. You can change the reflector or the lens for either or. And this is the same light you would see underwater.

LED lights? We're big fans of LEDs. Here, we're seeing some LED step lights on a Burger, the colour temperature now, the warmer whites, are quite pleasing and you can see here a very pretty effect—this is all on a Burger.

Halogen lighting—this is an underwater light for small boats—very nice, fairly cheap, again , the same fixture halogen in a spot or floodlight. This is the same fixture we would use for a metal halide—the halogen is a little cheaper, it's not ballasted and it's good for some situations. Again, halogen for low level lighting—this is a twin beam, adjustable beam, halogen, good for step or deck lighting. And again, more of a flood or spot light with the halogen.

So it just illustrates how we use the different technologies for different lighting situations. And again, the disciplines are new build, refit, repair and replacement. And they all have similarities. We get a lot of people phoning up the office, and it's a little bit discouraging sometimes but the questions follow a form. The first question is normally the price. Price is a big factor. And what does the fixture look like? Do we sell the lights for all the various applications?

Really what we should be looking at—and this applies to new builds, refits and every situation. The first question should always be what light effect is desired? We've got to look at it, whether there's a lighting engineer involved, there's a lighting plan, or even simply I want to light up my whole foredeck. This is where we start, the starting point. Then we move on to what light is suitable for the desired area? Is the light going to be robust enough, is it going to be effective there? And then, we bring in what technology we're going to use, and I think Bob illustrated this—we use LEDs in some situations, HIDs in other. Particularly underwater, for the bigger yachts, obviously HIDs are going to give us the light output that we need underwater. For spotlights on boats, HIDs again. For deck lighting—LEDs. We're becoming more and more an LED fan. Once those questions are sort of established, we can then look at the light output required, and in some of the fixtures we can give you different light outputs, depending on the area and how much you want. We can add LEDs, we can put higher wattage lamps in there, or lower wattage. Then we've got to look at the power requirements—is there going to be enough power to drive all this? Again, someone who can count better than me needs to do that. Serviceability? Very important. I don’t think I need to explain that. Durability? The lights have got to stand up to the marine environment. They’ve got to be designed for that. And they’ve also got to be designed for the area on the boat where they're going to used. If you're on the foredeck, obviously you're going to need a more robust fixture than on the aft deck or the owner's stateroom area. And then, spare parts? A lot of people don’t consider the spare parts required and also the availability of them. So a big, big consideration. And I'm just going to touch on custom lighting—because we're in the

custom industry, we get a lot of requests for custom lighting to make individual fixtures for a boat that are aesthetically very pleasing. Remember, these are one-offs, and if you want to go that route, please, please consider what's going to happen in 4 or 5 years' time when you want spare parts or replacement parts. If the manufacturer didn't make enough to supply custom lights, or he didn't go into production with them, you're going to have a problem. And this is an issue that we have to address a lot of the time. In fact, often we'll have to replace all the fixtures on the boat because it's cheaper to do that than to make custom lights for that particular situation. And then lastly, does it fit in with the budget and the costs? And we all know money is important, but you've got to make sure that the lights are going to do what they're intended to do in the environment they're going to be in.

Going into my methodology of lighting production—a lot of people seem to believe, especially when things go wrong, that we designed this light to fail, or with a very short life span. Not the truth, so by just illustrating what happens when we take a product, say from Osram, and develop it into a light. Obviously, it starts with an idea—it might be our idea, or sometimes customers come to us and ask us to produce a particular fixture. If we can produce it at the price, we'll do that, and if the numbers are right and sometimes even go into production with this. Obviously, it's designed using CAD techniques, which I have no idea how to work, but makes pretty pictures. We then have to go into a prototype—now, the prototype we do for two reasons. The first prototype we do is to make sure that the light is actually going to perform and be able to be used as designed. That means we take all the pieces, make sure that they all fit together and they're actually going to work. The problem with prototypes is they're very expensive. So if it doesn't work, you've got to do the whole thing again. Go back to the CAD, maybe make lengthier screw holes or whatever we have to do. We also make prototypes for the next stage, which is testing. And we do two types of testing—lab testing, which is in our workshop where we try and destroy them, and then field testing where we make a number of prototypes to go out in the field because it doesn't matter what you do in the workshop, you cannot duplicate what happens in the field. And these prototypes are quite a costly undertaking—they typically cost about 5, 10 times the cost of the fixture that you'll eventually buy. We then have to go through an approval process and this is frustrating for us because there's a cost involved, the cost can be from $4,000-$5,000 for Lloyds and ABS to $10,000 plus for UL approval, and there's a time frame. So we think we've got a good product, we've spent a lot of money getting to this point and now we have to sit and wait for a year, 18 months, for the approvals to come through. And it is a very frustrating process. We have to develop a pricing structure that's acceptable to everybody, do marketing, we have to make everything from magazine marketing to our technical sheets—all of it has to be produced and then the sales force have to know what they're selling and it has to go out and be sold, and then the final one, the nasty one, is a warranty, which can make or break you. Typically our fixtures—our warranty runs at 1% of production, so we think that's good, we'd like to do better but it's certainly affordable.

Then we have the other thing—we go to all this trouble to design these fixtures, make sure they work, and then they go out into the field. So I've got a couple of illustrations here I just want to show you. I call it technology meets stupidity. It's my sense of humour. This is a deck light that's obviously been destroyed in the field and it came back to us because they were a little bit annoyed that this happened. And looking at it, you can understand they would be. What we found out was—we supply this fixture with the screws for fastening to the structure. They decided that the screws we'd supplied weren't robust enough so they used their own screws to fasten the fixture to the yacht. Unfortunately, this torqued the white face plate there, which is the mating

surface for the lens, which has a rubber O ring sitting there, and this is all designed on CAD, very accurately, so when they distorted this fixture, water now came in. So it kind of illustrates what can happen in the field. Again, this is an underwater light from a small boat—the article on the left is the outside piece that you see on the outside of the boat; on the right is the inside body. The customer told us his fixture wasn't working, so we asked him to remove it and send it to us. When he tried to remove it, it fell apart—it was all held together with 5200—this was something we didn't design for, and the way this is fitted, you make a hole in the boat, the body of the lamp is pushed through the hole, the face then stops it going any further, you put adhesive caulk in to secure it, then on the back there's a round ring there that you can see secures it from the inside and keeps it in place. Our instructions are very specific—it says hand tighten only. Well, somebody put a wrench on it and that was the result. It could have been nasty. We hadn't designed for this, so we actually went back and went to a casting and made this whole fixture much more robust. So hopefully, this won't happen in the future. But it illustrates some of the problems we encounter. And then this is my favourite—this is a Central American owner called us up and told us his light wasn't working, so again we couldn't troubleshoot it, so we asked him to send them back so we could check them out, repair and send them back to him. And this is how they came—you can see the tekkie, the engineer, that removed it, did so without damaging the fixture, which is admirable, but he drilled the fibreglass transom all around the fixture and then cut that out. So now, he's got a huge hole in the transom to fill. We just sent him new lights with—please don't call us!! So we do get some unusual situations.

It's not all negative. There's a lot of good stuff happening, both in the custom world and in the production world. We do both, we produce lights, we manufacture lights and we sell—in fact, probably 70% of our business is for boats under 60 feet. And we have a worldwide operation. We're very, very enthusiastic about what's happening now. We've got the technology, we have the lighting systems now that are really going to come on in leaps and bounds. LEDs, I think, obviously are the buzzword, as we've heard today, but for general deck lighting, we see a lot of positives there. They're long lasting, low heat, low amperage draw as long as you don't overdrive them and expect too much; and they look very, very pleasing as you can see from some of the pictures of the Burgers.

Underwater lighting—obviously something we're really well known for. We're going into the bigger yachts for bigger apertures so we can get more volume of light, it means you can put less fixtures, they're a little bit more expensive. This is a picture of one for a steel yacht with a bigger aperture—a 250-watt metal halide lamp on it, we're just starting to get the technology where we're comfortable to go to 250-watt—and this one actually has its own self contained secondary containment area attached to the body of the lamp itself, which we designed for boats probably over 60 metres. So that's all positive, get in the higher wattage. And then, we're looking into strip lighting with LEDs, which is a few years away but we may one day be able to put a strip light all around the boat, recessed, which will give you lighting all around the boat or any areas that you want on the yacht. And this is coming along—we're going to introduce some of it in the Fall at the Boat Shows—our intention is to develop that as well because we see a lot of potential for that. So that's just a brief overview of how we adapt what Osram and other companies manufacture into the yachting situation. Thank you.

Martin

Ian, thank you very much. OK. Questions from the floor on this key subject? Remy, thank you?

Remy Millott Pinmar

Yes, just a question for Ian. Obviously, if you want to install an underwater light after the boat has been built, drilling a hole in the side of a boat is quite a drastic measure. What procedures do you have to go through in order to get the go-ahead to get a light in? Is it a complicated process in a fibreglass or a steel boat, drill a hole and put one of these lights in?

Ian

No, it's pretty, well, it's relatively simple. If we're talking steel and aluminium, you make a hole, the fixture is actually welded to the hull. The placement—if you're not sure about the placement we can advise, we can work off GA drawings, and where we can we'll even send somebody to the site. And then, once the fixture is welded in, the body of the lamp, which contains the bulb and the reflectors, is screwed on the back and the wiring is relatively simple. I would say in the megayacht area probably about 20% of our business is adding lights for the first time to boats, older vessels, or putting additional lights on fairly new vessels.

Remy

Is it pretty easy to get Lloyds approval for this?

Ian

Yes, the lights are all Lloyds and ABS approved. Initially, when we started this whole process a long time ago, it was a big issue and the individual surveyors often used to give us varying reasons why it couldn't be done, but it's so well known now, it's done everywhere—Europe, here in the States, South America, Australia, New Zealand. So I think most people are familiar with it now. So we very rarely have issues with Lloyds, ABS or any of the other authorities.

Martin

Will?

Will

Ian, you mentioned, just of the certification of the lights, it might take 12-16 months to get through that—you mentioned ABS and UL. If you get ABS approval, do you still need to go UL?

Ian

No, UL is a little different. In fact, UL is probably the most difficult one we have to get. UL are a lot more careful, they do actually test everything. And they'll do testing for water pressure, water proofing, they'll make sure all the wiring, everything, has to be UL approved. When they've completed their testing, they give us the approval but it doesn't stop there. We have to have a system in place for testing off the shop floor, which means that, as we're in production, they dictate for example every 10th lamp has to be pulled off and do XYZ testing. It doesn't even stop there. They then come

back into our facility unannounced at any time and check—they'll pull product off the shelf, open the boxes up, make sure everything in there is UL-approved, they will then check all our testing records to make sure we're doing the testing and keeping it all accurate and so they tend to be quite a tough cookie to deal with. Lloyds and ABS are just slow giving us approvals. It is very frustrating—the Ice Class—it's taken us 18 months to get Lloyds and ABS approval. And in that time, you know, you spent a lot of money getting there and you want to get it back, and you also know it's a good idea and you want to get it out there. Obviously, if you think you're first with the idea, you don't want to be following somebody else into the field a year later.

Will

Just on ABS, would that go through the approval cycle through Huston or New York?

Ian

I'm not sure. Randy, who's my partner in this business—he does the technical side and it's way too complex for me to understand. I just know the frustration.

Martin

Anything else? How much confusion still exists on the LED issues after our report about a year ago?

Ian

I think it's a big issue. There's certain companies out there—I think the product of underwater lights is probably the most copied product in my memory in yachting. I mean, we get copying all over the world. The LEDs have definitely got a place in the underwater lighting for small boats. I think Bob illustrated that, we strongly believe it. We have that technology available. If we think that technology is useful, we will use it. There are companies out there that are claiming LEDs can do jobs that they just can't do. They're just not capable of doing it. If you're an LED underwater light manufacturer, I guess that's what you should do and I guess my biggest grief is not that they're trying to come into the market, not that they're trying to be competitive, but they're not accurately portraying what the capability of that fixture is. And it's confusing. People are confused. We answer questions all the time about why don't you give me an LED? Well, it's honestly not ready for what you're wanting it to do. And I know we've lost sales to it. I think it's very important that the buyer is educated. And they must really pay attention. Don't believe the advertising. I mean, don't believe my advertising! Check it out.

Peter Ho Bradford Marine

This is for Ian. First of all Ian, I would like to congratulate you—you do have a wonderful product, we use Underwater Lights exclusively at Bradford. And to answer the question about LED or what, to us we have found that, if we give Underwater Lights the use, the size of the boat and what we want to achieve, that Underwater Lights normally comes up with the right solution. However, one of the questions that we're always asked is, how do you maintain the lights? Do you send a diver down with a scraper and scrape off the lenses, or what would you recommend to keep the lights clean?

Ian

That’s a good question. We recommend that, if you have underwater lights on whatever size boat, use them regularly, please. We don’t mind if you switch them on every day when you're running, the more you use them, the more reliable the components are. With the exterior growth on the lens—we've tried different anti-foulings, like clear anti foulings, prop speed, they all work to some degree, the heat from the HIDs tends to discourage growth so the more you use them, the more it discourages growth. But at the end of the day, jump over the side with a scrubbie brush and give it a quick scrub. For the interior maintenance of the components—very simple. The electronics—just make sure you're not seeing any corrosion, disassemble from the inside every 6 months—we supply Tefgel just to stop the reflector seizing. You tend to get a little condensation inside the units—it's unavoidable. By using it, it burns it off but it does create a little corrosion every now and then. But on the megayachts and HIDs—the bigger lights that we sell for underwater lights—we very rarely have any problems and there are people in this room who have probably had our lights for 8-10 years with very little maintenance issues. Does that answer the question? And thank you for the compliments, we appreciate your business. Discount? Sorry!

Martin

Yes, thank you, Don, at the back?

Don [From the floor]

Hi. As the son of an electrician, lighting has always fascinated me and, even to this day, I'll walk into a fixture store to buy a fluorescent lamp or something for the house and I can't just help wander around and look at the lights for at least a few minutes. I'm not saying I'm as big a lighting fixture enthusiast as a boating enthusiast, but the question I have is—planning and high-speed hulls. I do believe there are some underwater light applications—are you able to install lights on a high-speed hull bottom and get the surface of the hull flush enough so that you're not causing adverse drag effects, and do you frequently do installations like that?

Ian

Yeah, I mean obviously, drag is a factor you have to be aware of. The fastest boat to my knowledge we had underwater lights on runs about 150 miles an hour and is a Skada—people like Cigarette and Nortek that are famous for very fast boats utilise our lights. With Cigarette, they have a stepped hull so we actually install lights and a camera in the step itself facing aft. The owners like the camera so if they do hit anything they don’t have to jump over the side, they can just view the drives. On high speed megayachts, we've had no issues. I mean the drag is minimal, and by careful placement, it'll work fine.

Don

Thank you.

Martin

OK. Guys, thank you very much indeed.

As a quick roundup, you’re obviously the survival of the fittest here, thank you very much for your patience, your attendance and I hope you’ve enjoyed yourself. To summarise—I've learned an awful lot about the American market in this forum and I think ultimately, what it's proven to me is there's a huge amount of growth potential here and as a result of that, The Yacht Report and our conference programme is going to focus much more directly on the American market and I think you'll see some changes in The Yacht Report to this effect. So we're going to work closely with you guys, and look very closely at what's happening over here and maybe you'll see some interesting developments in our media group.

I'd like to say thank you to all our sponsors, all the people who've attended, and more importantly to my team, who have worked their little socks off. And thank you, Lisa.

And by way, I've just been handed this sort of encoded USB key on a dongle, if this belongs to anyone in this room? If not, we'll find out whose it is. Thank you—see you at the barbecue later on.