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**CREATING THE PERFECT ENGINE ROOM**

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Holger Hamann	Holger Hamann Consulting
Reza Kashani	Deicon Inc
Hubert Ohmayer	MTU Friedrichshafen GmbH

**Chairman— Martin Redmayne**

So this is the final session; an hour and a half discussion on creating a perfect engine room. What this means is that these four gentlemen to my right are going to discuss key issues that either go wrong or need to be considered to make sure that machinery space is not either over-engineered, has the wrong equipment in the wrong places, the usual stuff. We all know about these issues, again we want to try and make sure it's a debate as much as possible, very much an open forum, we have a short presentation from Holger, Hubert you're saying a few words as well, I believe, and Reza if we have time a few slides from you as well. And Chip—you do what Chip does and talk good stuff! Holger, thank you very much.

**Holger Hamann Holger Hamann Consulting**

Actually the idea of making this presentation is to give more sensibility in the engine room design, mainly because of the equipment nowadays which has to be installed and also about the future equipment which will come. But before I start first of all I want to thank three companies which is Peter Vantine Design, Wochem UF and my ex company Hamann AG who assisted me mainly in the area of delivering pictures or drawings. And as we are the absolutely last ones here in this session I also want to thank Martin and his crew for this really perfectly organised conference. Thank you.

Additionally I will try to make or to find also some background pictures which I really like but please note that the text or the pictures which I am presenting are not according to the background picture.

I think there might be a great canyon between the visions of owners, consultancies, shipyards, captains and designers. Why? Everybody knows that when an owner starts thinking about a yacht he starts finding a nice designer who is behind his visions so he draws a very nice boat with a lot of space inside for him, and then for a bit it goes around—2, 4 or 6 shipyards, and from the beginning nobody really cares about the equipment which has to be installed into the engine room, which is designed at the very beginning. And talking to several shipyards, surely it's so that they are giving up and for sure there will be no shipyard telling the owner—if you'll come to me, the engine room will be 5 metres more in length and it has to be completely on the breadth as well. Because then they won't get the order for it. So actually I think already here there starts the problem. I mean looking back, and it's really not so far away, just looking at what was installed on bigger boats and I think it's still the same on boats up 100 feet, what do we have? Just the 2 main engines, you had 2 generators, 120 kw or even less, you had the fuel filter, air conditioning, water maker, fresh water pressure system, hot water boiler, some pumps and actually that's it, isn't it. That's the point. But it is so that due to environmental regulations in the past and also which are coming in the future there's more things to install now. Which everybody knows. Sewage treatment plants, we have oily water separators, we have high fog systems, and mainly for cosmetic reasons more and

more is coming, exhaust gas cleaning as well, and OK everybody knows what MCA or IMO or other societies are requesting, which have to be installed into the ship. And also because of the additional engine room equipment plus above the engine room, generators are getting bigger as well. Nowadays two or three times 200Kw for a gen set is not unusual, and the other point is looking also to the gen sets following IMO regulations for the NRX reduction the exhaust flow rate is getting bigger, as an example, as those engines which I know most is Caterpillar, you have the C9s, the C18s, and you see on the C9s on a 9 litre engine they have an exhaust gas flow rate of an 11 litre engine and then the same percentage you have it also on the 18 litre engine. And the other thing is that the 3046, the old Caterpillar engine, has gone, it's not available any more so the point is if you come over 200Kw you have to swap from a 9 to an 18 litre engine, and then it comes back again to the exhaust cleaning systems, they will increase tremendously, the same thing like the sound on a Halliot system, they are going from a 9 to an 18 litre engine. It's out of the world, what has to be installed in the engine room. Which everybody has to think about.

The difficulty is you cannot fit all this into the already designed engine rooms. And there are only a few shipyards and I believe almost no designers who are thinking about this in the beginning. This means that as the engine rooms remain to what I said before, to a standard equipment, shipyards have to squeeze wherever they find a spot left to squeeze the system into it. So for me it doesn't make sense to install a sewage treatment plant underneath a king size bed in the VIP cabin, which I have seen several times. Or an oily water separator in the bilge, under the main engine. I have seen water makers underneath the control room of an engine room at the very edge, so you never ever could change the membranes on it. I will give you also some interesting examples out of my history because asking shipyards or engine room designers nobody was really happy to give me pictures of their installations so I had to go a little bit back to my past. As an example, this one here—there you find a unit and here you see the access to the unit which means that there is no chance of making any repairs and just filling up the chlorine tank you have to unscrew the staircase. Another point is sometimes you really have to search around to find the unit, at least I found it, but I couldn't see any accessibility to it. The access space is always in the area of the crew which you see up here; nicely mounted, some parts are reachable and I believe after one or two months the crew will still be asleep and the system starts at 2 o'clock in the morning. Another point is the working space. I think this one is quite nice. This is for me very comfortable to work in. And then on the shipyard side what's also quite forgotten is that looking a little way into the future that there should be a little space left to make here and there a refit possibility. Also here something was found and I believe that the trash and the vacuum cleaner was then afterwards brought to the owner's cabin. This one, OK, I put in, it's actually not on a yacht but searching around into all the photos I have in storage I found this one as well, which I thought I would show again as well, because I really like to eat panjano and the storage of panjano I think it's really tremendous and I think after installing a sewage treatment plant in the same room I think the taste is out of this world.

So what does the future hold? Due to the strong regulations of IMO or other organisations manufacturers have to act because the size of the equipment will get bigger as well. Looking forward to 2010 or looking also at the past, like oily water separators when it happened that IMO said now you have to follow up 5 ppm on the outlet the system had to be increased. The same thing will come up with sewage treatment following 2010 regulations. There will be no system anymore in the world which can deliver the same size as in the past. And then we have hull protection, exhaust gas cleaning, whatever comes in addition. So there's no way that the systems that will be installed are getting smaller. They're getting bigger. And there

attention has to be given. Green yacht concepts. That's also—more and more owners are looking into getting a green yacht also not only showing that they are environmentally friendly but also because they want to go into areas were no-one else will go, like Alaska or Antarctic or whatever. So systems have to follow the regulations which are local. And if you go into these systems it is easily that they will be 4 to 5 times bigger than what you know nowadays and mounting this one underneath the staircase—I mean you have steps which is really crazy. Typical Alaska type sewage treatment plant. You see here a Wochem UF system which joined during an acceptance test and I mean you see the complexity of such a system, it's really no way to bring it underneath a VIP cabin or whatever, but you really need space for it, and you need a lot of space also round the unit for maintenance and servicing. For me engine rooms have to be redesigned, it makes no sense that in the past an air conditioning system would be placed in the best spot of an engine room, where it does not need any maintenance and like this one, like a bio reactor, we would place it wherever you find a place, and unreachable. Let's have a look again—very close to it, you see all the valves, motors, you see all the pneumatic steering of a system and it doesn't matter if it's a Wochem system, or what else, all these bioreactors need space, they need attention, and they're ratewise a lot, and in addition they need more space tank size for a mixing tank which has to be installed or a sludge tank which has to be installed and all this has to be interfaced and integrated. So I believe we really have to think about this for the future.

Then we come to another problem. Looking again into the green ship concept as well as looking into 2010 regulations we have this problem as well. It looks a bit ugly but it's the truth. It's the waste handling. There's no way that any kind of food waste can enter the sewage stream, it will completely damage sewage treatment plants in whatever will be installed in the future. For me it's also that it should be forbidden to install any kind of macerators in sinks. And there are systems available that can handle the food waste but again here we have to have the space in the engine room.

**Tork**

Holger—can I just ask you why you would prefer macerators to be forbidden—

**Holger**

Because if you put the macerators in the sink it is very sure that what you have seen on the picture before will go somewhere into a grey water tank, and the grey water where it goes into the sewage plant and then you have a problem.

For me it is a must to place the systems according to mean time between service, mean time between repair, mean time between overhaul. You really have to look to the system which you will install nowadays and as I said before, you can't put an air conditioner in the best spot where you have something like a bioreactor or whatever somewhere into the bilge where you can't get to it. I see also here and there some advantages—everybody knows how difficult it is nowadays to get crew—give them a good place to work in and they will stay. I mean you saw the pictures beforehand. If you have to crawl down just only for service, a daily service, somewhere down into the bilge unreachable, or you have the emergency cases and when do you have emergency cases, always in the night, or when the owner's there and hopefully when he has a party as well. So you really have to see and look to place those systems which need most attention in the right spot. I hope that from now on more attention will be taken to the most important part of a yacht. And this is the engine room. Thank you very much.

**Martin**

Holger thank you very much. Hubert, would you like to say your few words?

**Hubert Ohmayer** MTU Friedrichshafen GmbH

When we have been asked to contribute to this forum we intended to bring an acoustic topic but there was no space left in the acoustic session so we are now in the engine room but we recognised that noise treatment, noise measure, are a perfect step towards a perfect engine room. That's why I want to show you some slides, just 5 or 6 slides, showing various options or technical solutions to reduce structure borne noise and at the end of the presentation I will ask you the questions how we should proceed in this direction.

As a standard solution we deliver every engine with a semi resilient mounting system; it's just a conical type which we use for commercial application for ships without special acoustic requirements. As a first option we have developed improved semi resilient mounting systems for ships with higher requirements for acoustic comfort. Yesterday you saw the paper of our partner Stopshock which we together developed a so-called active mounting system to reduce the structure borne noise on board ships and it's a combination of a passive rubber mount and active which further improves the acoustic comfort. Another option would be a double resilient mounting system with a base frame for even higher requirements. This 3D model shows an example. The first option would be again a double resilient mounting system but now including a gearbox to the double resilient mounting system, for we have to consider that it's not the engine alone—we always have to find a balance regarding noise emissions and dominating source is the diesel engine, but the next in the row is the gearbox. We have to consider that we have suitable coupling systems and mounting systems for the gearbox as well. If it is not quiet enough there will be a big advantage of an electric propulsion system or a technical solution for a generator set for an increasing demand of electrical power on board ships. And here we can have the selection to keep the system with or without sound enclosure, and especially sound enclosures could have a big influence on the machinery room, for a good influence the situation regarding radiated heat, ventilation system, fire extinguishing, things like this. To show you the technical features or properties of the various systems, distended systems allow us to reduce noise level down to about 80 db compared to about 95 which is measured directly at the engines' feet. The option no. 1 is about 10-15 db better, and as at 10 db we see improvement for the active mounting system—by the way the 60 db ten years ago was not achievable without a double resilient mounting system. Another 10 db is option no. 3. The option no. 4—you see, a little bit negative influence of the gearbox and the best solution in this row is the electrical solution or generator set solution with just above 40 db. Now I want to demonstrate this sound, we measure the structure borne noise, these are all solutions we already have built and the structure borne noise measurements are available, made on our test bench, and I want to demonstrate—it's loud at the beginning, I'm warning you. But step by step you can hear that it's getting lower and lower in noise.

[demonstration]

So I think it's really impressive how much the noise can be reduced by such systems but all these systems will have a big influence on the design of the machinery room. Our idea is to standardise such systems so that the shipyard is well informed in advance what it can expect, that they know all the information of the noise data, not only at the engine feet like we have demonstrated, also at the interfaces so that we deliver packages which make it easier to be integrated in the hopefully perfect engine room. Thank you.

**Martin**

Hubert, thank you very much. Reza. Do you want to follow on?

**Reza Kashani**      Deicon Inc

Good afternoon. Since noise and vibration is also near and dear to my heart I sort of continue talking about the same subjects, because after all, the source of it is in the engine room.

Noise and vibration have a very wide spectrum. Especially noise and indeed the number of octaves that we can hear is tremendous—9 octaves is where the human hearing is. And then you have this noise and the source of it which is normally vibration giving out energy and all of these frequencies corresponding to these 9 octaves. Now if I put my professorial hat on and give you maybe a ½ minute lecture—the lower the frequency of the sound is, the larger the wave length of that sound is. I mean we are talking about metres' worth of wave length of the sound when you get below 100 Hertz. And you know, the normal height of a human person is say 2 metres at the most, some people are a little taller than that so when you get to the very low frequencies one wavelength can cover the entire height of a person. Now if you get subjected to that kind of frequency the entire body get squeezed and then the pressure gets relieved. Many many times a second—20, 30, 100 times a second. So in addition to being a noise issue that bothers you in terms of hearing, it's also a fatiguing issue when it comes to the very low frequencies. And it doesn't take very long for somebody who gets exposed to this kind of perturbation to become tired, perhaps getting a little headache, and to start complaining. Now why is this a big issue when it comes to yachts? Because there are rooms on a yacht, we call them cabins, like the rooms in a house except that in a house you don't have a diesel generator operating all the time. Or any other sources of machinery. And I alluded to this yesterday, that diesel generators, depending on their rpm, they mostly start from very very low frequencies in terms of emanating energy vibration and noise, for example to another 12½ hertz, which is below the hearing threshold, is the beginning frequency and then it just goes up like that in terms of multiples of that frequency. So there are many of these harmonics, if you will, that fall in that range that I was talking about. What I call the low frequency range, the base range. And due to their very large wave length it's very difficult to get the energy out of them. Remember, to absorb energy you need sound absorbing material and the thickness of the sound absorbing material that you use is commensurate with the frequency that you're chasing. So when you are talking about 30, 40, 50 hertz, the wavelength of metres, then you need a decent amount of thickness of sound absorbing material to be able to go ahead and abate that energy. First of all, where do you put that much sound absorbing material—there's a lot of weight associated with the sound absorbing material and lastly, even if you're willing and can use that much sound absorbing material then you kill the speech spectrum of the frequency. When you talk in that kind of environment it's like talking in an anechoic chamber. So putting a lot of sound absorbing material, trying to go ahead and then chase the very low frequency disturbance in terms of noise and vibration is not really a very good solution. So what we need to do is go ahead and firstly make sure that it doesn't get to the rooms, to the cabins, and that goes back to the mounting that my colleague was talking about. You have to have a very decent mounting system which is good in all frequencies, and especially good at lower frequencies. So that's number 1—go after the source, make sure it doesn't get out of the source. And once it's out it always finds its way to go to the places it's not supposed to go.

Number 2 is something that very rarely do people pay a lot of attention to. It's looking at the design of those cabins, the geometry, the shape, the dimensions. You know, these things are very easy to do these days and sometimes changing the geometry a little here, a little there, would make the resonance of the room not to match any of

those frequencies. Now some of you guys might ask well, the resonance of the room, we heard resonance of a structure, what is the resonance of a room? Well, believe it or not, once you enclose the acoustics of a system, as in a room, then there are resonances associated with that which are very profound at low frequencies. So if these low frequency perturbations leave your diesel generator or main engine and find their way into the room, then they will perturb those resonances and then, not only do they not get absorbed, they get amplified. So outside that room that noise might be acceptable—you step into the room and close the door and that noise is not acceptable any more. So a little bit of perhaps analysis work ahead of time would go a long way to get around a lot of these problems. I can't emphasise the importance of going after the noise to begin with, or perhaps modifying some of the interior designs, how important that is in terms of getting around a lot of the noise and vibration issues later on. So that was one thing I wanted to talk about.

Since I am still on the subject of noise and vibration issues, in addition to the vibration of the engine itself generating noise, there are other sources of noise generation also associated with engines. One of them is the induction noise, it might be a little bit of an unfamiliar term here. The thing is that these are internal combustion engines. And they breathe, they take a lot of air in as the pistons go up and down they take the air in, they do the combustion, and then they send the product of the combustion out. As that air is going in through the air filter, there is an awful lot of noise associated with that. So addressing the induction noise, now that cannot be addressed by mounting or anything like that, but proper ducting and proper design of the induction system is also instrumental in lowering the amount of noise that gets generated out of the engine. Another thing that again is related to engine room as far as noise and vibration is concerned especially noise, is the ventilation that's required in the engine room. You have these big big engines and when they run they generate an awful lot of heat especially around the turbo charger and the exhaust system, and they need to be cooled, so that is why there is ventilation in these rooms. So you want to make sure that first off you have a decent ventilation, the air gets distributed properly, especially when it's needed the most, which is around the sources of heat. And secondly, the noise associated with this ventilation is also addressed when you're designing the engine room. One more thing is—letting this ventilated air out, it normally shows up in the deck area and then you have this duct letting a lot of air out and also sucking a lot of air in, and that's where the owner sits, and people are trying to have a little peace and quiet. You want to make sure that that ducting system that lets the air in and out of the engine room to the open deck is also addressed, as the noise and vibration are. I guess that's the core of what I wanted to talk about—this morning I sat down outside and ran a few simulations and generated some plots to show you what I mean by resonance of a room. And I guess if time allows I can go ahead and show 2 or 3 of these pictures.

Well, again back to low frequency room acoustics. Here again, I don't want to go back and repeat what I said. I just want to show you what I mean by room acoustics. Rooms are normally made up of sometimes parallel walls, sometimes not so much parallel and there are indentations in the room and furniture, and sound equipment perhaps, audio visual systems in the room. And they all influence how sound gets going back and forth between the walls and at certain frequencies when it gets reflected off one wall and hits the other wall and gets reflected back exactly on top of the previous reflection. And that causes build up of sound at that particular frequency. You go up or lower from that frequency the build up goes away. That's what they call the resonance of the room. Acousticians call it the standing waves in the room. This is one picture of it, and it's not really difficult to go ahead and analyse them ahead of time. These resonances happen at all frequencies but at higher frequencies there are so many of them, packed up so close to each other, that they

nullify the effect of one another, but at lower frequencies they are very distinct, far apart from each other in frequency and very very noticeable and when they get amplified, the phenomenon I just talked about happens. The whole body gets squeezed and relieved and doesn't take very long to get to that headache I was talking about. To analyse them, all you need to do is basically go ahead and put the geometry on the computer, break it down into smaller pieces, finite elements, is what they call them, and then just go ahead and do the particular analysis, the jargon for it is modal analysis—and then the computer tells you that hey, these are the frequencies that you have to be worried about and these are the shapes of these standing waves in the room. For example this bottom shape is one of them—red means high pressure positive, blue means high pressure negative. The ears don't really care whether they are negative or positive. So as you go from one corner of that room to the other corner, you hear a lot of loud sounds when you are close to the corners, close to the walls, and very very quiet sounds when you are in the middle of the room. Now normally people sit close to the walls, that's where the chairs are—in the middle of the room you normally put perhaps a table or something. So you expose yourself to this kind of very uncomfortable noise when they get set off and start rumbling, if you like. Now this is another one, just looking at a different resonance of the same room. One is a 34hertz—once you put the little indentation in that room, just a little change in geometry, it changes the resonant frequency. So 34 becomes 35½. Now 34 might be matching an objectionable frequency from the engine room but 35½ doesn't. So a little change can go a long way in terms of addressing some of these problems. This is showing you the effect of putting some furniture and audio visual systems for example. You have a leather sofa at one end and then you have a couple of speakers and a TV at the other end and a table in the middle of the room. This resonance, if there was none of this stuff in the room, would have looked like what you see on the left hand side, high in the bottom, high negative on the top, nothing in the middle when you go from bottom to top. But as soon as you put the stuff in it, that changes the resonant frequency and also it changes the shade of that standing wave. What if some of the walls are not rigid enough? Now most walls are not rigid but when the walls start vibrating they change also the resonance of the room too. They change the shape, they change the frequency, so if the walls are all rigid you have this resonance, 34hertz, with that shape, when they are not rigid, here I am assuming one wall is not rigid and the rest of them are rigid, and it changes again the frequencies and mode shapes. And those are standing waves. So it is very useful if we can do this ahead of time. It can be done, as soon as you know the drawing of the room, you can do this analysis ahead of time and put the boundary conditions that you think the system has in it, and then it tells you what the frequencies are and what the standing waves look like. And this analysis goes a long way in terms of helping you properly design and basically even put the audio visual equipment in the room. Where do I put the speakers? I have the sub woofer, if I put it here it makes the room different in terms of the character at low frequencies. If you put it some place else it just makes the listening experience a little different. I so wanted to share with you the low frequency aspects of a room realising that you have this big machinery in the engine room which emanates energy at those frequencies, you just want to make sure that these two do not really talk to each other, they don't match. Thank you.

### **Martin**

Chip—your words of wisdom.

### **Chip van Gunten Northern Lights**

Good afternoon everybody. Just a couple of things I wanted to touch on that Holger brought up. Talking about how much space is available in the engine room for service and maintenance and future major rebuilds and so forth—we see a lot of

times in many vessels there's just not enough room to take a 500 Kw generator end out without dismantling the whole vessel and moving other major components. So that's just certainly an area that we would like to have the engine room designers thinking about.

But more importantly I think we need to be looking at exhaust after-treatment systems. This is going to become more and more important as we move forward—we're seeing that the requirements for these are coming after the vessel has been delivered, there's some time put on the generator sets as well as main engines and the owners or engineers may not be as happy as they thought they would be with the levels of particulate that are being emitted from the new engines that we're seeing. Just as a defence of the engine companies we are able now to supply to the end users the cleanest engines that are available to man. We can't make them any cleaner. If you look in the on highway diesel engine market you'll see that as we move into the EPA requirements that the engine and truck manufacturers are talking about exhaust after-treatment to reach the next level of particulate levels that need to be met. So with that's stating is that the engine manufacturers have done everything they can internally in the combustion stream to clean it up and now to meet the next levels we're seeing that after treatment and that can be anywhere from catalytic converters, particulate matter filters with regeneration, as it relates to the marine market, particularly with generator sets. We get wet systems or combination wet and dry, or we can capture any particulate and oily discharge that's coming through the exhaust stream, can be captured and filtered out and all these components are taking up more and more space in the engine compartments. So there's something that during the design stage of the vessels we need to look at, and have the yards and engineers and designers start asking the questions and making accommodations for that. We've also talked in the past—years ago we had load banks on boats to go ahead and make sure that the generators and engines were loaded up properly, we have gone through getting better with our load management and power management systems on board boats, but now we're getting back to a situation where we're over-sizing generator sets again to accommodate larger bow thrusters, or zero speed stabilisation and now we're being forced to look back at load banks again. So this is another area we can put some consideration into. And I don't want to take up any more time because I know we want to start asking questions so thank you.

**Martin**

OK Chip, thank you very much. We've got time for a little open debate on the subject; any show of hands before I throw a few questions across the room?

**Tork**

While we're waiting for volunteers, I would presume that the issue of a properly arranged engine room is considerably more difficult on a sailing yacht than it would be on a motor yacht of equivalent size, due to the different hull form?

**Holger Hamann**

Yes surely, the sailing yacht is for sure the most difficult one. We see it also very much on the *Ethereal* project at Royal Huisman where the owners really wanted everything 100% environmentally and the point is that his vessel, because of this, increased at least by 5 metres because of the additional equipment he wanted to have in it.

**Tork**

But at least on that project he has actually tried to factor in a refit.

**Holger**

Yes, refit is another issue of course. And that's what I tried to point out as well, that shipyards at least should find a possibility to keep space somewhere for additional equipment which has to be added in the future.

**Martin**

Can I ask the manufacturers, naming MTU and Northern Lights, how involved do you get in the design process of this machinery space, if at all?

**Chip**

I'll answer that first—we would like to get more involved especially when it comes to the exhaust system designs. You asked about sailboats and that certainly presents another whole set of issues for us but in many cases we supply the drawings, we supply recommendations for exhaust runs to the shipyards and we will sometimes get the drawings back from them, sometimes not, or we get drawings and then when the boat is getting ready to be delivered and we go for first startup the installation looks nothing like what we saw on paper. We find in many cases that once the big equipment is put in, especially generator sets in their sound enclosures, the main engines and the main engine exhaust which in many cases takes up quite a bit of space, they go oh, yes, we need to put the generator exhaust in. Well get me a muffler and some piping and some hoses—and we see some unbelievable systems that should not be put in the vessels. So we do want to get involved, we try our best to be on site and when we see something we bring it to their attention but in general it's not as much as you would think we would be involved.

**Martin**

Does it ever affect your products' performance and therefore warranty?

**Chip**

Absolutely. In many cases the more complex the exhaust runs are, you have back pressure increase situations and right away we have specifications for back pressure readings, if they are exceeded then we are going to see sooting, carbon collection, all kinds of problems will occur. And getting into loading the generators—the first 100 hours or so is always an issue we can talk about with generators—but just the configuration of the exhaust systems can be a real nightmare. Also fuel systems I guess is something which is a good point to bring up with the perfect engine room; with these new high pressure fuel systems it's incredibly important to make sure that the return lines are open when you first start up the generator sets. We've had some cases where the supply line was open, the generators were bled, everything's ready to go, the return line was left closed and the generator was started and blew all the seals out of the injection pump. No that's not a warranty.

**Tork**

From the various conversations about silencing generator sets it would appear to me that not only does the all electric ship offer all sorts of advantages in terms of running the prime generators in their optimum area, it also allows the ultimate flexibility for the arrangement of the engine rooms. Not only where the engine room is but also within the engine room, how you position the generators if you're using multiple gen sets?

**Chip**

Certainly we had a discussion today with a client by the stand and you can put the generators athwart ships, fore and aft, anywhere you want to put them, put them in special sound proof rooms, put them in enclosures with extra mounting, that's certainly going to be—it'll be interesting to see how this progresses through the future.

**Martin**

OK we have a question from the floor.

**Clive Oxford** Windlass

Clive Oxford, I'm a chief engineer. Operational. I just have a couple of points I'd like to make (I keep hearing myself over the speakers here, it's a bit bizarre). From a practical point of view the operation of an engine room is physically and mentally demanding and you introduce a lot of complexities with a poorly designed engine room. What happens, what I've seen and I think many engineers would agree, is the emphasis is on creating an illusion of space and a grandeur in the guest areas at the expense of technical areas. And that complicates the maintenance of the equipment for the engineers and puts them under pressure. This also affects crew areas, which ties in with longevity and retaining crew. But most people will know about this but still as we speak yachts are designed with little attention to these important issues.

**Tork**

I was going to say, as a working engineer, the modern trend towards distributing services throughout a number of machinery spaces rather than simply just the main engine room, you'll often find spaces where there are water makers and the whole water system may be in a separate space—is that something that you find operationally useful, or is it not?

**Clive**

You have to use the space efficiently and you don't want to waste space but as far as maintaining the equipment goes, if you make equipment actually difficult to get to then you've only got so many hours in the day and then if you can't maintain things properly because you can't get to them, things don't get maintained properly and this influences refit costs and ongoing expenses for the owner that they don't realise, they think oh it's great to have this extra space. But when you hand them the €2million refit bill that could really have been €1million if things had been designed properly perhaps they would consider it would be better not to have that extra space that they weren't going to use anyway.

**Martin**

Holger, please?

**Holger**

That's actually what I tried to say in my presentation, is that I think all of us, suppliers, designers, shipyards, captains, engineers, should give the realisation to the owner that they have to increase the engine rooms, and if they don't want to lower their interior space there's no way they're getting the ship a bit longer, not giving enough space if more equipment has to be installed, which would make from my side—the engine room can remain, but at least a technical room has to be designed somewhere to get all this equipment in.

**Clive**

Another point I'd like to mention is the tenders are very important in the ship's operation and there's been a big trend moving tenders inside the vessel whereas in days gone by they'd be on the aft deck or on the upper decks on the exterior, so that's impacted usable space inside the vessels for other technical requirements. Sometimes I think owners need more information, I think it's easier to sign a deal than what it is to build a vessel. And it's more difficult and more time consuming to find a crew who can run a vessel properly, efficiently and professionally. And if you've got a happy crew then they'll work better and create a better atmosphere on board

which will translate to more enjoyment for the owner and the crew. Thanks very much.

**Holger**

Yes that's quite right. If you've seen the complexity of the bioreactor, as an example, and I've seen vessels where they had seven engineers in one year, and tell me how the seventh engineer can run the ship like this—so again it is very important to design an engine room in a perfect way, as I tried to explain, so then you have a happy crew and the engineer and whoever will stay there, that's quite right.

**Martin**

Any more hands?

**Holger**

I've one more thing in the direction of the engine supplies. Especially when it comes to refits but also for new builds. There's always the question about the back pressure and for example talking to MTU, from the start-up they say 50 millibars, and that's it. And then if you talk and talk and talk then sometimes you're coming up to 75 or even 100 millibars. I don't know how it is with Northern Lights. The point is if you want to install additional equipment behind the gen set like particular filters and Caruli converters or what exhaust systems, there's a need for a minimum of 100 millibars, and I think you should work on it, that it's stated from the beginning.

**Hubert**

Yes, you are pretty right. 20 years ago we even have been much more sensitive, we were talking about 30 millibars, meanwhile we were used to 100 and the new developments have considered this, it means that 50 millibars are a design figure. As long as this level is kept we guarantee all our figures in technical catalogues, so—sometimes it means higher back pressure, increases the temperatures, moves the efficiency of turbo chargers and things like that. But we are aware that we have to go in this direction, that we have to accept at least 100 millibars.

**Holger**

It is so that with the gen sets you are moving from now on, everybody knows you can handle 100 millibars.

**Hubert**

Our modern engines, modern series like 2000, 4000, 8000 they can.

**Holger**

OK. So everybody knows now! How's it with Northern Lights?

**Chip**

I think the answer to the question—with the turbo charged engines 30" of water if you will—the after-treatment that you mentioned, we're seeing the new generation of after treatment equipment is highly sensitive, it recognises the back pressure issues we so far have not seen, if the system's properly maintained and installed and monitored then we can stay within the range of the back pressures that we would like to see. You also mentioned that in some cases we as engine manufacturers have a stated back pressure—the boat's delivered, the tests are done and it exceeds that. Now what do we do? We can go in and divert water or request a change in the exhaust system and where it gets to be a problem is where there's no options in the vessel, no place to put a bigger pipe, move a muffler, you can't divert any more water or you get into a heat issue, and there's some flexibility in the numbers of back pressure but we'd need to stick to this, this is our baseline number, this is where we want to be,

this is where we need to be. If we do have to live with a higher pressure, depending on what the parameters are, there's going to be lower life with turbo chargers—lower life was imaging upon it. So it is something that we could say, OK we can accept that on this installation perhaps. But in the big picture the back pressure has to be maintained within our standards if we're going to be have any luck in warranting the engines for their time and also have the engines perform to the requirements that the owner will need.

**Holger**

But that doesn't say really your figures, does it?

**Chip**

As far as—what are our figures? Is that what you're asking? Or do they change? For each individual model we have specific back pressure requirements for each model engine, depending on 4 cylinders, 6 cylinders, generally turbo chargers are 20 to 30 inches of water back pressure.

**Holger**

What is that in millibars, exactly?

**Chip**

I don't know the millibars.

**Holger**

Does somebody know?

**Chip**

So does that answer your question?

**Holger**

Partly, yes.

**Martin**

We have a question over there, thank you?

**Phil Noad** Cayman Islands Shipping Registry

Just one of the other boxes which I feel needs to be ticked in the design process is the proximity of certain items of equipment to each other, just as a safety issue, the failure of one system, maybe a fire risk, high pressure fuel we know about, lubrications, oil, high pressure water near switchboards, and that sort of thing. So just to bear that in mind when you're designing a layout is the *what if*. What are the consequences of failure of this or that. Some of it is just corrosion, with the constant dripping, or failure of a gasket and it damages equipment below, or damages the seals. So there are some safety issues as well in the layout as well as the access and space issues.

**Martin**

Thank you. My question is really—who designs the engine room? Is there such a thing as an engine room designer, apart from Holger?

**Holger**

I mean sure we have engine room designers like Peter Valentine but what I said before is, the point is that the start of a design is done by the designer who's designing the vessel, but mainly outside and the interior, and there's just a given space for the engine room and what I tried to say as well is that the shipyard has to

stick with it. If they say well we have to increase the engine room, they won't get the order. Isn't that so? But again, if everybody is working on the designers and giving hints to the owners as well, there might be a possibility in getting more space into the engine room. Because if we look at regarding 2010 you can't put a system anymore underneath a staircase, there's just not the space available. And the shipyards have to wake up and have to look to the future. And the owners and designers as well.

**Martin**

So who's at fault. The shipyards primarily?

**Holger**

The shipyards, they actually have the bad cart. It's so, isn't it? I mean the other part is the shipyards that are doing these series vessels at 200 feet, or something like that. They're designing for the owners, surely the most possible space is in the interior and they squeeze whatever it is, even the main engines, inside, just giving as much as they have as most owners who are buying the vessel.

**Martin**

But Holger, in your experience, is there a formula for what percentage of the vessel should be allocated to machinery?

**Holger**

Actually not, because they are so different, the vessels. It is quite impossible to get a formula out of it.

**Tork**

I get the impression that the accommodations are designed and what's left is allotted to engine room, rather than what actually would be another system's approach, in another vehicle, where you start with the equipment space and then work outward from there.

**Holger**

Yes, and that's not the right thing on a boat.

**Martin**

Alan Gilbert, thank you?

**Alan Gilbert**     Gilbert Yacht Design

I think in many ways this is a nice wrap up for the last three days. On the first day we heard that 80% of the owners just don't care. Then we talked about how we've got all of this to work out amongst ourselves. Unfortunately it's been my experience that a lot of the owners don't care, and they are sold on those areas of the vessel that they're familiar with, that make an impact. And often the mechanicals are the stepchild. Who's at fault? We're all at fault. I've fought tooth and nail—I was speaking to somebody earlier, they're just begging for another frame in an engine room—there was a comment from an engineer, I like to say out of sight, out of mind. As good an engineer as you might be, if you had to be contorted 10 different ways and you can't get to that item, that is going to receive the least of your attention, so I think it's a collective thing that we have to fight for. And in terms of laying out the engine room, it's my experience that the naval architect puts in the big pieces and then in consultation with the owner's technical people, puts in the second level pieces. And then once the yard is selected then you get the input from the yard to refine the whole thing. In summary, there are very few projects that aren't increased in length on paper that I have been involved in, and there are very few projects that I have been involved in where the owner after technical delivery says you know, the boat

could have been 2 metres bigger. I think that's a good problem because he'll probably come back if he has any money left. Thank you.

**Martin**

Alan, thank you very much. Any more comments out there?

**Holger**

I think it's quite right what you said. If at least the naval architects are looking to the main components, which has to be installed, also looking a little bit into the future, and just putting this space into it, that gives a big chance to the shipyard then selecting whatever different kind of manufacturers which will fit in and yes, take machine rooms at least base-wise designed, for this process to be installed. That's right.

**Martin**

OK. Deathly silence. You're all exhausted, obviously. Brain drain. Anything else you want to say? Listen Holger, what would your recommendation be then for this equation for a perfect engine room. What is your wish list? That you all sit in a room and design it together? Or would that be just chaotic?

**Holger**

My wish is really that designers from the very beginning, or consultants, you have so many consultants who are following the owner and talking to the naval architects that from the very beginning they are contacting either the shipyards or other companies to help them in the technical part as well. That's my key point.

**Martin**

OK. So my question is, is it feasible to create, or have you even seen a perfect engine room in your years, decades even?

**Holger**

I've seen around 3,000 yachts above 100 feet and I would say maybe 1% they were quite nice.

**Martin**

And could you name those 30 yachts?

**Holger**

No. I won't.

**Martin**

Well I'm just thinking would they be benchmark yachts for the future that you could talk about.

**Holger**

No I won't say any names. Sorry.

**Martin**

Spoil sport. We'll discuss that later. OK, anything else to take from the floor now?

**Tork**

I've got one thing to add which was if any of you were in the earlier session on cons, at the very end Andrew Schofield was asked about the guaranteed contention ratio—he wasn't able to answer it at the time but he texted me around the beginning of this and asked me to pass on to those of you who may be interested. The

guaranteed contention ratio for their system is 4:1 or 5:1 depending on which level of service you purchase. There is some more data which he is getting and will put on the forum, which again reminds us that we can continue to use these forums through to the next GSF to continue the discussions we've been having here.

**Martin**

I have a knight in shining armour with a microphone to save the day.

**Richard Blake** Cayman Islands Shipping Registry

Just to keep things moving—a couple of quick points. Earlier we discussed the back pressures on the diesels and things. I just wanted to bring up, because no-one mentioned it at the time, about non-compliance and the technical codes that are provided with the AIPPs, obviously also give some limits to the back pressures that can be put on, before those certificates become invalid, so that's another concern. And the other thing was with regards to more and more equipment going into the engine rooms, where there's more and more mandatable regulations and talking about the owner and the designer—and these people—the owner does have technical representation as well and it's not only refit and being able to access his equipment that's going to make the life of serving chief engineers like our friend at the back here more difficult, you look at the operational issues as well. The number of yachts available that are out there trading in the Mediterranean at the moment without a bilge tank for instance; it's a special area, they can't use oily water separators, they've only got small sludge tanks, so they're going to have water washing around in the bilges. There are other issues that we've not really touched on so far.

**Martin**

Any comment? You nearly kept it moving. I'm going to throw something back at you actually. Surely your responsibility as flag state from a safety point of view is if the machinery space is unsafe to operate does that have any impact on issuing the certificate, from a technical operational point of view?

**Richard**

Well of course if the machinery space is unsafe in any way or doesn't comply with the regulations—my colleague mentioned about fuel systems and shielding of the fuel systems, such things, that's something that we would pick up during the initial building surveys. Also the materials being used; for instance there's a proliferation of plastic pipes throughout shipping but obviously we all know about it; it's a sea water system, you've got a danger of flooding when it comes to fire, application of shipside valves and these sort of things and their accessibility to the loadline, these are all issues that we would pick up on and would deal with during the build. Obviously we're all aware of yachts that are in service which don't comply 100%, whether it's an oversight or something that was missed or something was agreed for some other reason, I can't really comment. But these things should have been picked up during the build.

**Martin**

But does unserviceable equipment declare an engine room unsafe in any way?

**Richard**

Well it depends what equipment you're talking about, doesn't it. You know, moving away from the engine room slightly—if your emergency generator is unserviceable, couldn't be maintained and was found not to work then you're talking about a prohibition notice and the yacht staying alongside until it's fixed. At the other end of it

if the air conditioning for the guest accommodation doesn't work properly but they can open the portholes or windows to get ventilation as required then that's not an issue for us.

**Martin**

OK, thank you. One last question, Holger. What about the provision of spare parts space?

**Holger**

OK that's another point, for sure yes.

**Martin**

Is that a big issue too from your perspective? From a crew perspective it's huge.

**Holger**

It depends on the size of the yacht. But I would say if you have a 70 metre yacht for spare parts you need a minimum of 20 square metres if you really pack it correctly. That's surely another point.

**Martin**

And is that common, or are you seeing it changing?

**Holger**

Yachts will really start carrying around spare parts from the beginning, two or three years' spare parts list—from all the yachts which are built, I would say it's about 30% are doing it. And I'm quite sure that they look for adequate space for it. But the other point which I have seen as well is that also here something, but this is totally different, that's just managing the spare part room as well, I've seen engineers where also whatever, the third or fourth engineer, he even doesn't know what he has on board because there's no management behind it. But that's another point.

**Martin**

Anything else? OK. My engine's burnt out, I think we'll call it a wrap, thank you very much gentlemen for your time. I enjoyed it. It's hard at the final session of any conference when everyone's so exhausted after parties and bars and what have you. But thank you very much indeed for your time, your input, we've enjoyed it, it's probably going to fill the next 20 issues of The Yacht Report. We'll see you again and thank you for your attention and your patience with me. Especially Michael Murray, you've been wonderful.

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