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Power Management

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Martin Redmayne

Good morning everyone. Thank you very much for being prompt; I'm sorry I'm 5mins behind schedule, that was my fault. Caffeine does flow quite quickly at this time of the morning.

We're going to start the session dead ahead, Power Management, an issue that I think sometimes you hear about—overloads, underloads, lots of issues with equipment draining the main systems that we hear about, various at anchor stabilisation systems that are very very power thirsty, lots of new things come onto boats that require extreme amounts of power. The four guys to my right are really going to open the discussion more than actually just talk at you. Reza's going to start off on his pet subject, then open the discussion for the 3 other gentlemen to discuss power management, and the various issues related to that. So I'm going to introduce Reza from Deicon, and then the other 3 gentlemen will have their little 5-10 minute say as well. So over to you Reza.

Reza Kashani Deicon Inc

Good morning. I was told to stick to this microphone as much as possible. Today I'm going to go ahead and discuss this power equipment from a slightly different angle. I'm not going to talk a lot about how to size the power equipment, overpowering, underpowering, things like that. I'm going to go ahead and talk about some unintended consequences of having the power equipment and also the interior design of the boat in such a way that the acoustics of rooms, some of them at least, sort of start sounding boomy and uncomfortable and tiring. So with that little introduction you might ask yourself, what does power equipment have to do with room acoustics.

Well let's start from the power equipment side and I'm sure most of you guys are familiar with the fact that power equipment operates at normally a certain frequency, for example diesel generators, depending on whether it's in Europe or the US, they operate either at 1500rpm or at 1800rpm. So let's talk about a diesel generator built for operation in Europe. Once these machines start operating they basically generate vibration and consequently noise at certain frequencies, and those frequencies are related to the rpm of the machine itself. I have a couple of traces here and I don't intend to lecture here as to what a power spectrum is and all of that, but very very quickly I get your attention to the fact that you see a lot of vibration and sound energy at certain frequencies and that's what those peaks are. These two traces were measured off a 75metre yacht while the diesel generator was operating. As you can see, those frequencies are also very nicely distributed and they are all higher order harmonics of the lowest frequency which just happens to be 12½ hertz. So if you

have a diesel generator intended for operation in Europe you ahead of time know what those frequencies are. So with that in mind let's go ahead and talk a little bit about the room. Well believe it or not, rooms have also resonances. Very much the same way as a structures have resonances. And again similar to structures if you perturb the room acoustically at their resonances they basically sound very loud and uncomfortable. So do we know ahead of time that whose resonant frequencies are? Well, the answer is yes. If you know the shape and the geometry of the room, if the shape is simple you can really do back of the envelope calculation and calculate those and if the shape is a little bit complex then we can just go ahead and use computer models and predict what those frequencies are. They basically start at low frequencies and go to high frequencies. The high frequency resonances are not really much of a problem because all these rooms, cabins, suites, and all that, they have enough sound absorbing material built into them, fibre glass, mineral wool, things like that so they can do a pretty good job adding damping and absorbing energy at high frequencies but low frequencies are different matters altogether. Low frequencies as you all know, when it comes to sound, have very long wave lengths and again I'm not going to lecture you about wave lengths and relationships to frequencies and all that. But as an example, just to put things in perspective, I basically put an example of relationship between wave length and the frequency of sound there. A 50hertz sound, which is considered a low frequency, has a wave length of 7metres. A 25hertz sound, which is still audible and feelable, has a wave length of 14metres, pretty long. Realising that absorbing the energy of sound with a wave length that long requires an awful lot of sound absorbing material, and if you put enough sound absorbing material to go ahead and absorb that kind of resonance there would not be enough room in that room for someone to get into it. So using passive sound absorbing material is not really an option when it comes to the low frequency resonances of the room. So having that in mind, let's go ahead and start building the relationship between the power equipment and the room. We learned that power equipment basically operates at certain frequencies and they perturb the structure of the boat at those frequencies and we also learned that sound at certain frequencies plays a lot louder in some rooms than others because of those low frequency resonances. Now if these two sets of frequencies match, then we have problems. A couple of years ago I was called on to go ahead and take a look at this very very nice recently built beautiful yacht, a 50 metre one. And the owner was complaining about his study room, as well as the master suite, but more specifically the study room, being very uncomfortable. He didn’t have a degree in physics, he couldn’t put his finger on it as to what the problem was, he just said it's uncomfortable, it's rumbly, it's boomy. And I sit behind the desk in this study room, and this is a little schematic of that room, sort of like a squarish cabin, a desk in the middle, a chair behind the desk. And he said, in addition to being uncomfortable in terms of acoustics, when I put my feet on the floor I feel a bit of vibration coming from the floor too. In fact really that vibration was playing into the room very much like a gigantic subwoofer, if you will, and making this room sound very boomy. So what I did, I basically turned the diesel generator off and put a speaker into the room and measured the frequency response of the room. And that’s what those two traces are. If you pay attention to the red trace, again you see a very peaky peak at 75hertz. And remember one of the frequencies that I showed you at the beginning on those two traces, measured off a diesel generator, there is definitely a component at 75hertz coming off the diesel generator. I also went ahead and put the dimensions and geometry of this room onto the computer and sure enough I came up with the resonance, the acousticians call it a standing wave, exactly at 75 hertz. And that’s that little image on the top. You see a very high pressure level, the red, that is, at one corner of the room, high positive, and you also see a high negative pressure at the opposite corner. That’s the blue, and then you have the variation of pressure going from one corner to the other. That’s what the resonance is. And his chair was

close to one of these high pressure level regions. So his ears, being sort of pressure sensors, were situated at exactly the wrong place. And that's what gave him this very uncomfortable and tiring feeling. He was, as I said, also complaining about the vibration of the floor that was really contributing to this boominess to begin with. Then he also complained about the master suite so we went ahead and did some measurements of the master suite, unfortunately the lines are not showing here, there is a line going around the room, the bed in the middle, a couple of chairs at the two corners, and then we came up with a 25hertz resonance corresponding to this geometry and this set of dimensions. Massive sweep of beam all across the yacht. So remember those frequencies also had a 25hertz component to them. The 25hertz component of the diesel generator was setting off the resonance at 25hertz in the master suite, the 75hertz one was setting off the resonance in the study room. So we sort of identified what the problem was, what do we do about it. Well we do whatever we have to do in dealing with any resonance problem, being structural or acoustic. It really doesn't matter. You have two choices. You either have to absorb the energy of that resonance, in other words add damping to it, either structural if you have a structural problem, or acoustic if you have acoustical problem. That's one approach. And the other approach is do your best not to excite it to begin with, which is probably going after the root cause of the problem. The latter is probably a more a favourable solution and I might add a little bit more expensive to implement. So going after this not exciting it to begin with, because that's the more favourable solution, how do we make sure that we don't excite the resonance of the room. Well, you know ahead of time what the frequencies of perturbation are off the diesel generator or any other power equipment there is. Again, if you have a diesel generator in Europe, 12½, 25, 37½, 50 and on and on. So you know that ahead of time. So ask the interior decorator to go ahead and dimension the rooms to the degree possible so that the resonances of the room do not match the operating frequencies or the higher order harmonics of the operating frequency of the diesel generator. Now sometimes it's not possible because he or she has many other constraints also, when he or she is designing the geometry, the location, the shape and all those things of the room. But if it is possible by all means, if the yacht is still on the drawing board, make sure that these two do not match. This is not a very heavenly match. Make sure it doesn't occur. But let's say you cannot do anything about it. The yacht is already built, or you have certain constraints you can't really go ahead and re-dimension the rooms and all that. Then you'd better go ahead and add damping to that room. Now a minute ago I mentioned that if you want to go ahead and use sound absorbing material like glass fibre or mineral wool, you have to use an awful lot of it if you chase a 25hertz resonance. Remember, 14 metres worth of wavelength. That's not quite an option. The alternative is, using technology. We have this electronic, if you will, feedback controlled damper which can be tuned up to 2 frequencies of the room and when it's tuned right, it basically goes ahead and absorbs the energy. Only at those 2 frequencies. And remember one or two of those frequencies are troublesome to begin with. You have a little picture of it back there, it's really the size of a 10" sub woofer this high, and can very easily fit in the corner of the room, where it couples nicely to the resonance that you're chasing, and it does a pretty good job, adding damping to that room. I have a couple of traces and if I have time at the end of my talk I come back and talk about it, because it takes a little bit of time explaining it. So let me skip that trace in the middle which shows before and after the use of such damper and then talk about the other alternative, which was avoid exciting the room to begin with, which is probably the preferred way of going after the problem. Well, realising that the power equipment most notably the diesel generator, especially the big ones when they're under full load, they are really the source of the problem to begin with, then you want to make sure that when you isolate those diesel generators, put an awful lot of emphasis on the low frequency isolation. Now most isolators do a very good job at high frequencies, a 95% isolation efficiency at high

requirements is very very routine, even using simple rubber. Low frequencies are a different matter altogether. And what we normally preach and promote is using air. You have probably seen air mounts and air isolators under an awful lot of trucks out there. They are very durable, they are very efficient and if they can survive the truck environment driving on all that slush and ice and snow and rain and all of that, day in and day out, they can definitely survive in an engine room. The problem is that this nice, beautiful, high efficiency low frequency isolation comes at the expense of softness. So you have to go ahead and do a little more than putting 4 air mounts under the diesel generator. You have to have computer controls in place, lateral mounts that engage and disengage and all of these things in there. And that's really what we promote as well. Going ahead and adding a lot of emphasis on the low frequency in addition to the high frequency. I'm not saying ignore the high frequency, in addition to it. But put a lot of emphasis on the low frequency isolation so the low frequency perturbation doesn't get to the room to excite the system. And by the way, this approach is what the owner of that motor yacht, acted on. We then retrofitted the isolation system on his diesel generators and then he became a very very happy person after that. He started using the yacht more often. So. To summarise. Identify the problem. Then propose solutions for it. The problem was an unintended unfortunate match, not made in heaven. And that match is the noise and vibration of the power equipment most notably diesel generators matching the resonant frequencies of rooms. It's not a very desirable thing, it's uncomfortable when it happens, if you are in that room you really feel tired. You'll feel it more than you hear it. And you have this boominess, this rumbly, sort of like a high school kid with a sub woofer in his car that you can hear from 3 blocks away. That kind of sound is being felt and heard, when that happens. Solutions? Well either not having rooms with the troublesome resonant frequencies because you can do the calculations ahead of time and if that is not possible then you go ahead and think about absorbing the energy of sound at those frequencies and realising that absorbing the energy of sound at very low frequencies using passive sound absorbing material is not really an option, then one can approach this electronic technology based approach, feedback control based approach, to do so. And I just want to add here that this is not active noise cancellation by the way. It's not that headset thing. This is a truly feedback controlled damping solution, not cancellation solution. And if someone needs to have some more information I'll be more than happy to talk about it later. And so that's one alternative. And perhaps the better alternative is make sure that those troublesome frequencies do not reach the room. Put a lot of emphasis on the low frequency isolation of the power equipment, as well as the high frequency. But not just the high frequency ignoring the low frequencies. See that those low frequency perturbing sounds do not really set off the resonances of the room. There, I'm done.

Martin

Reza, thank you very much. Tom, do you want to kick off the session up there with your presentation?

Tom Sullivan Atlas Marine Systems LLP

Good morning everybody. Can you hear me OK? I'm going to talk this morning about load analysis and automated power management systems, shore power, and then I have one chart at the end that's not related to anything.

The load analysis is quite an important thing to try to determine how much power is required, how often the loads are operating and the way our company does load analysis we try to come up with a kilowatt number of the boat with all systems on and

operating and then their normal on and off cycling mode. In other words the air conditioning is on in all spaces and the thermostats are turning the air conditioner on and off as needed. When you first fire up an air conditioner system in a hot boat everything would be higher than the result of this load analysis. But we define it as all electrical loads are turned on in the normal cycling on and off mode. Lights, pumps, air conditioners. We're often asked to provide a third party analysis of a load to solve an argument or just give an independent assessment of it and we've learned to try to standardise how we do this, and we always use the same usage factors. Often we see people, even different people at the same shipyard using different usage factors and getting results that are not consistent. So we use the same usage factors in all our load analysis, we come up with a number and after the project is over we try to get feedback from sea trials and the boat usage on exactly how close we came. And if necessary we apply an overall adjustment factor to that number on the next project to make it in line. But we use the same process, the same mechanism, all the way through and if anything needs to be tweaked we do just one valve, to turn it up or down a little bit. Interestingly enough this overall adjustment factor we apply is different in smaller boats than bigger boats. There's a statistical fact called the central axis theorem that says the more times you flip a coin the closer you'll get to the average, which is 50%. So on a smaller boat there's less circuits that can be on or off and so there's a wider, you can't get as close to the average as you can with a bigger boat. And with a bigger boat you can zero in on it and there's always a slightly larger overall adjustment factor on the bigger boats to compensate for it. Another complicating thing, once you get this number, you're going to find that sometimes you're above that number, sometimes you're below it. It's a base line, and throughout the day the loading will vary, depending on the boat, and typically we see boats have a larger loading in the early evening round the dinner hour, and lower loading during the night. This chart used to be purple all the way through but we couldn’t see the red line on it so they changed the background to white yesterday. It shows 24hours and we show that around 6 a.m. the load is starting to peak up during the breakfast hour and then goes lower during the centre of the day. If this was a charter boat, for instance, at the end of the day the galley would get going, people are taking showers, using the hairdryers, the cranes are putting the toys away, and we see a peak there and then it drops off through the midnight hour back to the night level. And I think Chip is going to talk about a very important thing about this—and that’s the load number. If the generators are picked the wrong size you end up with them underloaded a lot of the time and it's rough on the engine and makes pollution, and some problems that Chip will talk about. Since this chart was made there's been the invention of the zero speed stabilisers and that loading through the night is probably higher now on a modern yacht with zero speed stabilisers than it would be on this particular example. This shows a peak kilowatts of 80 kilowatts and I drew an average line across it, 50, to talk about power management systems. The power management system can automatically start and parallel the second generator to handle peak loads and then shut them off when they're not needed. And it can also do load shedding; this is our first peak in the morning, instead of starting the generator for an hour then shutting it back off, you can shed some of the load and then when the load drops back down, reconnect it. A way that typical loads are shed are water makers and hot water heaters, sometimes a stage of air conditioning, but this shows how the power management system can prevent that generator from starting in the morning. The next 3 charts show functions of a power management system, as I said they can automatically start generators based on load demand, parallel the generators, you can do seamless transfers to the shore, what you do is you sample the shore frequency and change the speed of a generator to match the phase and frequency of the shore then close the shore breaker and quickly open the generator breaker and you can transfer between generators, shore and back. You can set it up to automatically rotate the generators, run each generator for 12 hours

during the day or any other thing you want to do to balance the run hours. Load control—you can shed or reapply loads —class boats require load shedding and there's 3 basic ways to do that. One is you can have the power management system trip breaker, that takes the load off, and to get the load back on you have to manually reset the breaker. A second way is, for instance with a water heater, you can put a contactor in the circuit that supplies the water heater and that would shed the load and then when the load comes back down reconnect it automatically. A third way is to get into a motor control circuit, as if a stop and start button were in place where it could take a stage of the air conditioning out and put it back in. If a load is not running and you do a load control on it you can block it from coming on, you can enable load banks, if you don't have enough load to load the generators you can have a load bank come in. And one that's quite common is to, if there's a large electric motor for a bow thruster you can tell the system that you want to run the bow thruster and it will automatically start in parallel with the 2nd generator on line and report back when the system is ready to take the big load. Then when the big load is over put it back into its normal state. There's this third chart, to prevent dead buses, you can shed shore cord parameters, not only if you have a shore supply that's say 100kva rating, as you get close to 100kva rating it would automatically start a generator. We can do more, we can communicate between the switchboard and the frequency converter and the converter knows what the voltage in current of each shore cord is, and if it's plugged into—in other words if you've got 100amp cords and you don't have a 100 amp outlet you plug it into 50 amp outlets. You can tell the system that. And as the shore cords approach full load well before the frequency converter rating is reached it can automatically start and put a generator on line. Power management can also communicate with alarm monitoring and control system and provide all of the data up on the bridge, you can start and stop the generators from the bridge and anywhere else in the vessel. That's to an Ethernet connection, switchboard talks to the frequency converter with Ethernet and talks to the vessel alarm monitoring over the Ethernet and everything goes straight through. This is a block diagram of an automated power management system, we use an industrial Plc high temperature, high vibration, very reliable, inexpensive, and the operator interface is the coloured touch screen, up here, and we also can go directly to the vessel alarm monitoring system. The way it works is there's sensors, then the decision maker with software and then the actuators, and if we wanted to do for instance the seamless transfer we would tell the motorised circuit breaker to close and for feedback we would look for the auxiliary contacts to report back to the Plc that that breaker is closed, then it'll take the next step, which would be to open the breaker on the shore side and report back when it did it. If it didn't do it, it would create an error to say that it's under command and nothing worked. Digital meters tell the kva voltage current levels all through the system and we can operate the generator governor to speed up or slow down. Timers, if something doesn't happen in a certain amount of time, or to do generator rotation and create alarms. One thing I want to point out is if you have a vessel alarm monitoring system and you want to take the measurements of the electrical system the kilowatts, volts, and all that stuff, you have to put transducers and current transformers in the electrical system to provide that data. If you have the automated power management system you already have that in the digital meters, it's just a matter of communicating through, so there's a saving there. This is a chart of the benefits. The electrical system is easier to operate, crew friendly and I added even a caveman can operate it. We present a one line diagram of the system and if you want it to transfer to a generator you touch that generator and when it starts it turns from green to red and when the breaker closes the breaker turns red. It's very easy to operate. Minimise power disturbances, and a generator pre alarm for instance—if your generator's going to shut down if there's a problem with over temperature in the water we set the generator shutdown at 250°F.

We can add a second temperature sensor set at a slightly lower temperature and connect that to the switchboard. As that temperature starts to go up, the switchboard would see it before it got to the point where it's going to shut the generator off and stop the system, it could automatically start and parallel in the second generator and shut the first generator down before it fails and prevent a dead bus. Some design philosophies on yachts are to have as modern as possible and this is the major component of an automated vessel to have the main power system automated. And if you have automated switchboard and frequency converter together you can connect to any shore power source in the world and as I said, you can communicate shore cord data back to the system. Very importantly, it increases the present and future value of the vessel, in the present it makes the system easier to operate and in the future you get your money back when you sell the vessel. I've got two charts of shore power and one of the challenges of shore power is that half of the world is the wrong frequency. In order to plug in a boat without a frequency converter you have to match the source with what the boat needs. It has to be exactly the same voltage, if it's a three phase boat you can't plug it into single phase, and you've always got to have the right frequency. The shore power converters can handle any of those and make exactly what the boat needs. Some marinas in Europe the generators are not allowed, and we were talking before the presentation here about the likelihood that the West Coast here is going to have rules where you won't be able to run generators in marinas. No world wide standard for receptacles and plugs, and RCD circuit breakers are interesting. In the early days, frequency converters could be two cords could parallel together. Now with the RCD circuit breakers, these are the circuit breakers that are used in Europe and the southern hemisphere, they look for the same amount of current that goes out of the cable to come back to the same cable, otherwise they think that some of the current is being shunted to ground and there's a fault there, and it creates a dangerous situation and it shuts the circuit off. When you mechanically and metallicly connect the two cords together inside the frequency converter it creates a path for current to go out of one cord and return on the other cord, and will trip the RCD circuit breakers. And you have to do special things with the converters to prevent that from happening. This is an example of shore power around the world. The Caribbean for instance, I've never been there, but I'm told that in St Martin, that it's 50cycle on one side and 60 cycle on the other and wherever you go it's just a pot pourri of voltages and frequencies. The biggest one is between the 50cycle countries and the 60cycle countries. I want to say one thing; most of the converters are permanently installed on the boats and go with the boats, but sometimes marinas will buy a converter, to accommodate boats visiting their marinas and the marina will sort it out. People with 50cycle boats when they come here in the States if they know they can get 50 cycle power at your marina they'll come to your marina. This is the last chart, it's the one I was talking about, it's not related to power management, we did a presentation with Alan Gilbert and Dick Gee in 2004 and my part of the presentation was the effect on the electrical power system if shipyards are creating bigger and bigger boats. In other words what happens, and this is an example of it. We went to a file and found that some of our designs for the 100ft boat had a mile of power cable, the 125foot had 1.5 miles, and the 150foot boat had 3 miles. And when you plot that on a graph it's exponential. Alan Gilbert says when he does this, he thinks that exponential is 2.5, in other words if you double the boat length it's more than four times the amount of power cable in it. That's not just power cable, that's everything. It's manhours to build the boat, the manhours to put this cable in, the manhours to purchase it, the storage, the cost, the weight, everything is about that same factor. So as the systems get up into bigger and bigger boats the infrastructure kind of has to change to accommodate it, and this is just a typical example of all items that the same thing happens to. And that's all I have.

Martin

Tom, thank you very much. Alright now, what I'm going to do is make this turn into the problem solution discussion, with Chip starting off with a few of his observations and the marketing people will have something to say at the end of that, then we'll throw the floor open for questions. So Chip please start off.

Chip van Gunten Northern Lights

Thank you Martin. Good morning everybody. First of all I'd just like to say Tom's explanation of load analysis was excellent and the importance of accurate and detailed load analysis can't be stressed enough. One of the premises of this panel discussion was to talk about generator sizing and obviously the load analysis does that for you. Not only do you get the total connected load of the generator of the vessel but with the usage factors, as Tom was saying, that's where the finesses of the load analysis is important for selecting generators that you're going to be installing on the vessel. I just wanted to comment—Tom mentioned that when they do the load analysis they have the usage factors, they do the installation at the yard, the boat's put into service and they go back to survey the crew to see how close they were. Well that's extremely important; we have had experience with a particular builder, the boat was built with para 65 kw generator sets with parallel, this was their standard installation, the boat was delivered and the first crew and captain that was on the boat complained that there wasn't enough power. The boat was eventually repowered with para 99 kw sets, everyone was happy, then the crew and captain were replaced and the next step was that they complained there was too much power on the boat. And none of the equipment had changed. Just the use of the vessel and the way the crew were using the equipment. The boat was eventually repowered with a para 65 again. So what's the right size generator? I don't have the answer. Again, that load analysis is critical. Especially obviously for new constructions, you'll be using that to do the initial calculations for your base loads that you're going to need for class purposes as well as your different scenarios whether the boat's in transit with just a crew on board, full charter, at anchor. You'll find the usage factors will be all over the place and it can be as much as a 35-40-50% power difference between some of those scenarios. So again, that is something that we encourage and we ask when yards and engineers and designers give us a call and say well, what size do you think we need? We ask for the load analysis and the more detail there is in it the easier it is for us to guide the yard, to answer the question as to what size generator. I was thinking about something yesterday—we heard a lot of in the old days, when an 85foot boat was a big boat, we used to be able to size a generator pretty simply. We would take the total connected load of the equipment, this would be just on the phone with the boat owner. How many air conditioners do you have, water heaters, stove, add it up and take that number, say 60-70% of that number and come up with a ballpark for generator size. And honestly, that was a pretty accurate assessment. That's no longer the case, obviously. You look at the myriad of systems installed on these vessels, we no longer need one hot tub, we need 3, we no longer can be satisfied with just stabilisers under way, now we need to have zero speed stabilisers, those consumers—I was just talking to Dick Gee this morning and looking at a load analysis for another builder, the zero speed stabilisers require two 20hp power packs, and this took the load analysis that we were looking at from what we felt the boat could get away with, say a pair of 80kw generator sets, now up to either 99 or over 100 kws to satisfy the owner's request that only one generator be running at a time. And as you can see, the more we talk about sizing generators, it's not only that the load analysis of what the equipment is going to need but also the requirements of the owner of the vessel and here's where we start to talk

about what's the right mix of generators on board. Do we take 2 generators the same size, that will become parallel for the heavier loads, and say a third generator for the night set, or do we go to 3 different size generators where they're sized for the different scenarios we talked about? And this is debated, it goes back and forth and again it goes to what really the owner is requesting and what's the use of the vessel going to be. Is it going to be strictly charter, is it going to floating around with just the crew on it most of the time, so those are considerations we should talk about. We talked about 3 generators, 2 generators, loading, Tom did mention I did want to talk about the problems with underloading generator sets. Two things, one—historically we have talked about the generator sets wanting to maintain a 60% load factor. That's basically for a duty cycle we'd like to see that engine work at 60% of its rated power over the duty cycle. That still holds true. We need also to talk about electronic engines and I wanted to bring this up because I'm sure someone's going to ask me about it—the thought is, with these new electronic engines with the ECUs that control the fuel flow, the timing of the engine and so forth, they are far more forgiving for underload situations. Because of their ability to control the fuel burned in the cylinder. However, when—and this was the question I asked Dick Gee this morning—I said what do we say, do we have a number, is there a minimum load requirement and we default back to that 60%. It's still a diesel engine, yes they're more forgiving, the new electronic ones, do we know for a fact that they can be run at 20-30% load for 24 hrs, 48 hrs, without any ill effects? No we don't know that. Do we know if the engines are going to last longer, or the time between overhauls? We're just seeing now the electronic generator sets getting up into the 8-9-10,000 hour ranges so it'll be interesting to see how much longer these new engines will go before we start seeing a necessity to rebuild them. Along with the loading it is still imperative that the engines are broken in properly. Even with the new electronic engines the engine manufacturer that we use has not changed their break in procedure. And that is to maintain at least a 75% load for the first 100 hours of operation and no less than 50%. Now this is a problem, we find that the boats are getting larger and larger, the vessels end up being put into water during construction perhaps to get that stage payment from the owner for whatever reason, get it out of the shed and get it into the water. There may not be power available to run everything to finish the construction so they put these generator sets on, put them on line and they're producing just enough to run table saws and some compressors for tools and so forth. And we can see several hundreds of hours put on these generator sets with extremely low loads and in the past with the mechanical engines it was a big issue. The boat would be delivered, they would start to load it up and we'd start to see smoking issues, sheen on the water and of course then the yard would come to us and say your generators are no good, and we'd say well you didn't do the break in. Well we can't, and we'd go back and forth with this. And the engines would have to be opened up and the cylinder liners rehoned and put back together. So again, these days with the new electronic engines we're not seeing that, we haven't experienced that yet. We're also requesting that—and the yards have been through the lessons so they know we have to put some load banks on these generators at the first hours of their lives to get them loaded up properly. Let's see what else can I talk about quickly here. I wanted to touch on how class and flag can affect generator sizing. In the example I stated earlier, I said we thought a pair of 99kw sets would be fine for a vessel, but when we started adding the toys and the big loads of thrusters and stabilisers the generators had to be kicked up over 100kws. That's a threshold for the class societies when we need to start full classification on the generator sets and that's a cost factor for the yard and for the owners to consider. Also emergency sets; we are getting into the size of vessels where they're required to carry an emergency generator set and there are rules that are put in place saying that for emergency use they can't be tied into the main bus but in some cases the builders want to tie into the main bus for harbour

use so please check the rules with your surveyors on that. Those generator sets do require some very interesting installation issues because they need to be above the water line and we've found that we're dealing now with radiator cooled sets, then we're dealing with the noise levels of radiator cooling, how to get the cooling air through this, so there are a lot of things to talk about. And I guess I'll pass it on.

Mark Woodward Asea Power Systems

Good morning all. One of the things I'd like to touch on real quick here, and I'll be brief so we have time for questions and answers, is better communications being developed between the owners, the builders, and the marina operators. Very quickly outpacing the marina power capabilities is the size of the boats and the electrical loads being applied to that marina. We're seeing boats now at 100 metres being built that are taking close to a megawatt on some of the large boats now. However the boats are being specified with a number of cords that far exceed what the marina can do even with several cords being laid, up to 4 and 5 on some of these larger boats. So I think one of the things that needs to be done is a better channel of communications being opened up between the builders and the marinas where these boats are going to be operated in. The owner needs to be able to tell the builder to convey this information where he plans on using the boat, he needs to do a good survey of his operational areas, how he plans to use the boat, where he plans on hooking up so these marinas can begin to upgrade. There is some upgrade taking place right now but from what we've observed we're seeing 5 boats built that require power greater than dual 250amp cords for every one marina that's actually performing an upgrade in power. At some point in the next couple of years this is going to become a major problem. You're going to have a lot of large yachts out there with no place to hook up. And with this green movement taking place what's going to happen with these boats? They're not going to be able to operate the generators in the harbours, so it's going to be a real problem to be dealt with. And it takes a while for marinas to upgrade power. It's not a matter of just dropping in a large pedestal, putting in some large terminal blocks, they need to be able to bring the power in from the support infrastructure. The local city utilities. So this takes many years. At the same time, boats are being built now, and I would imagine that there's probably 60-70 boats that I'm aware of that have an electrical capacity larger than any marina I know. This information really needs to be passed downwards to the marina operators so they can begin working on their end too. Number of cords? That was one of the possible solutions. We're seeing pressure, because of the rental costs of a per cord situation, a lot of builders are trying to standardise on one very large cord. The same problem takes place. As Tom mentioned, in Europe now we see a lot more of the RCD [residual current device] type breakers. However combining power from these is not a very easy solution so some of the old stopgap measures that were used 5 or 10 years ago are no longer applicable throughout the world. Multiple cords is one possible solution that can be employed, however the builders and owners are fighting this so some type of solution needs to be found. Some dialogue needs to take place between the marina operators and the builders. Along with communications we're finding, as far as usage on these boats, a lot of the builders are trying for ease of procurement, ease of manufacturability, to standardise on a specific power level for a given yacht size. I don't think that enough dialogue takes place during the planning phase between the owners, the owners agents, the captains and the builder as to how is this boat being used. We see perhaps a 3 to1 difference in power usage for a given boat size. We'll see 115foot boats, some work just fine on 30 kva of power, other boats are struggling to manage how the owner wishes to maintain that boat to be used at 100 kva. So much better lines of communication throughout the build process between owners, owners agents and builders, the marina operators. The level of sophistication we're seeing on the boat is

now demanding much more sophisticated levels of electrical management on board at much smaller boat sizes. In the past you wouldn't get into energy management systems until you were onto a 40-50 metre boat. It didn't have, below that point, requirements for seamless transfer energy management, load management. Nowadays we're beginning to see the owner of a boat that's been built at the 70-80-90foot level requiring this. He knows he's paying out $2-5million and for that money, it's a significant amount of change, and he's demanding the same levels of sophistication as he sees on some of the larger boats at the boat shows. I think some level of attention needs to be paid towards satisfying these demands, some type of solution being brought out, a solution being developed by manufacturers that they can appease this. It is a big chunk of change and these owners are demanding it. I think right now we probably only have another 15 minutes for questions and answers so I'll pass.

Martin

Let me throw one question right back at you. Why is the dialogue not happening?

Mark

Nobody's forcing it. Everybody just wants to take care of what's best for themselves I think. The builders are trying to appease the owner, the owner knows that he wants to run the boat in a certain fashion, and it's not a problem yet because there's probably 15-20 places in the world that can accommodate the power demands of a multiple 250amp services, but in another 2-3 years, when a lot of the boats under development are all out there operating, I think the marinas are going to be caught off guard, the infrastructure won't be developed yet, and we're going to have a bunch of annoyed owners who are going to be toddling around with no place to tie up. So I think someone needs to force the issue. I think a dialogue needs to be opened up. And someone needs to compare notes, to see what's taking place in the industry.

Martin

And what is the capital investment to make that power supply available?

Mark

I don't know. It varies by locale and what the local infrastructure is.

Martin

But is it significant?

Mark

It's significant. But I suspect it's not just for the marina operators to be significant. They probably will have the lesser burden. I think the biggest is the local municipalities. Do they have the capacity? You're talking about a superyacht that is going to want to tie up and consume 900kva of power. That's a lot of homes it's displacing. And I don't think the distribution systems are in place. And that may take 5-10 years to develop for a municipality.

Martin

Thanks Mark. We'll throw it open to the floor now. Any hands? Yes, thank you Graeme.

Graeme Lord International Yacht Collection

This is a bit of a hot button for me, because I've been involved in a lot of surveys and we manage quite a few boats and with all the technology you just never really see it being gotten right on the power management. My experience with it, and it becomes a finger pointing exercise, and I've been sitting here listening today that the builder should do this and that. The builders aren't the experts in the way in which to power up a yacht. I think the suppliers are the experts. The same goes with the marinas, saying someone should speak to the marinas. I don't know who that someone is, but I'd say the people who make their living out of selling equipment to yachts, that use power, should be that someone. But it all goes back to the thing that's bothering me at the moment, it's taking responsibility for this. If a generator is supplied to a boat, and it's not the right size generator, what is the supplier doing to make that right. And the other thing that's bothering me is that the example of the first 100 hours. On all the constructions I've seen, other than the start up, where the supplier is there, I've never seen anyone say hey guys, you need to do this with the generator for the first 10 hours. You need to do XYZ. And here it is documented, and Mr Owner's representative, here is the documentation of what you guys need to be doing. And there's a clear history that all this stuff was communicated to everybody other than a manual that just gets stuck under a bed somewhere and disappears.

Martin

Chip?

Chip

I take it that was addressed to me. Your points are very well taken and let me address the break in first. We honestly do try to express to the yard the importance of the break in. When we do our sales contracts to supply the equipment I guess there's a point. Do we put in there, no warranty on generators if you can't prove that there was a heavy load put on it for the first 100 hours? There's no way to prove that. The break in procedures, and this is still a hot button issue with some builders we have, they're asking us now to supply the generators broken in. And we have talked about this a lot. In order for us to do that, we would have to run the generators at load for 100 hours. We do not have the production capability to tie up the test cell equipment to do that and still meet the supply demands we have for our customers, so this is something I'm personally looking into right now to see what's a reasonable cost to charge a yard for this, someone has to be paid for not only the personnel to be standing by to watch the generator run, but also the additional equipment investment for the load, and also to see if this is a viable option for everyone. As far as the responsibility issue goes, this is very interesting. We normally all of us in this industry find out whose responsibility things are when the lawyers start to talk. And none of us are trying to point the finger of blame at anyone else, intentionally, but when we start to look at a specific problem during construction there's going to be a point where it says yes, well, this is the cause of this issue and how do we avoid it. Perhaps we do need to put on our sales orders 100hour break in load required. And I don't know what we do if you don't. Do we not give a warranty? I mean can you tell the customer with a $30million vessel that well because we didn't run the generators properly you have no warranty on them? That's not going to work. So I think the responsibility comes, you'll hear us say the yard, the management, and so forth. We talked about this a little bit yesterday. The owner's representative, as well as the

owner, the representative may be a project manager, may be an individual guy, a project manager, or may be a lawyer, needs to be informed on what the expectations are for each of the companies involved. What are the expectations of the generator manufacturer. If the generators are the wrong size, is that our fault they're the wrong size? We sell equipment that makes electricity. We ask you how much electricity do you want. And we sell you that product. Is it our fault that by the end of the project there was miscalculation on a load analysis or an additional equipment put on? And now two or three generators have to run to put a sports fishing boat in the water with a crane. Is that our responsibility? I don't think so. But yes it has to fall on someone's lap. Unfortunately it's usually the yard because that's the people who are collecting the money from the owner. And then the yard goes to the suppliers to seek relief. But yes, it's a problem.

Martin

Thank you. In the front here.

John Corrough The Corrough Consulting Group

I'm going to be one of your speakers tomorrow and as far as I'm able to tell I'm the person that's supposed to be speaking for the marinas, so I'll just jump right in here. There are three things that are key to planning and designing facilities for megayachts which we are doing quite a bit of as are other people. Obviously the two traditional ones are navigability and capacity of the facility itself. Just physical capability to handle larger vessels. The second is staffing and service support, which is much different as we all know from megayachts and so forth. The third, and the one that is the subject of this discussion, is the infrastructure and I'll just end by giving you a classic example of one of 32 projects we're involved in right now that all have this same question whether they're an isolated resort or part of a municipal infrastructure system. Vancouver, adjacent to the new beautiful Vancouver waterfront, Vancouver conference centre is being built and a megayacht facility is to be constructed along with a number of other things as a part of that. The projections for the demand from that megayacht facility, which is fairly modest, about 32 berths ranging from about an average of 135-140 feet all the way up to 400feet. The projected electrical demand for that will at peak demand equal the demand for the entire conference centre and surrounding area, when it's in normal operation. We cannot get the architects and the municipal people to get their heads around this kind of demand. It is a major issue, not only there but in the remote and wonderful resorts that we're being asked to create which used to just be water and sewage treatment and basic electrical power, now we're needing to produce power that is equivalent to all the power that's used on the entire island of Tahiti for example. And so this is a real challenge for those of us who have to provide home port, positioning port and destination ports for all of the things that are the subject of this conference. Please talk to us at the front end of the process about what we can do in working with you as an industry on this, because we're desperately caught in the middle. Thank you.

Martin

John, thank you. Jeff please.

Jeffrey Benneville Camper & Nicholsons

Mark, to your point. I had a meeting last week in New York with the man behind this large marina expansion, specifically geared for large yachts, 60-88metre, this is the Island Global Yachting Group. And I specifically asked him about what they're doing

as a marina developer to address the electrical needs of vessels this large. And he immediately threw in a DVD and there was a fair amount of video dedicated to the custom boxes that he's just installed, 600 amp. He has assured me that all of his facilities are going to address the large yacht needs where you don't have this problem where you can't plug in. And I think the industry is probably going to hold him to that. But from what I've heard from the large yachts that have stayed down at his facility in St Thomas, he's actually pulling it off. So I think this particular individual has heard that loud and clear and if I can get my hands on that video that has the technical specifications of that box I'll be glad to send it to you.

Martin

All right. Janine, right at the back there, in the middle.

Todd Roberts The Marine Group Boat Works

Good morning, I'm Todd Roberts with the Marine Group here in San Diego. My question is, if you were building a superyacht facility that could accommodate boats say 60-110metres, what's the magic number. How much power per berth?

Martin

The magic question!

Mark

Well I'd have to take a paper and pencil to it and work out that type of number. I don't have anything in my head right now. But I can do that for you. If you meet with me later on, I can write some stuff down and we can begin working on it and get back to you.

Chris Dlugokecki Lloyd's Register North America, Inc

I guess we all know that there are a number of initiatives going on with development of standards for what we call cold ironing, or the plugging in of onshore power. ISO is developing some standards, IEC is involved in a development committee, a technical committee, that's been formed to put together a standard and Lloyds actually sits on the committee of IEC to provide recommendations on the development of standards for cold ironing. I'm not really sure who the question will go to—but how do you see it playing out, the playing field between the two standards that are out there, or the standards that are being developed between ISO and IEC and the second question is, for our industry, the industry being the yacht industry here, does anyone in this room sit on a technical committee for developing of those standards to provide recommendations for this specific market.

Martin

I'd say no!

Steve Austin Port of San Diego

I appreciate your dialogue this morning, certainly acknowledge the comment that communication needs to be taking place, and I would just encourage you to expand that horizon to include what you have alluded to, the power companies, the municipalities, but one other entity which hasn't been mentioned that you may be

wanting to partner with would be the cruise ships. You think you've got problems! The cold ironing demands and requirements that are going to be probably mandated as a result of, and probably first and foremost in California as most of these sort of things do originate, as a result of diesel emissions requirements. Eventually there's going to come a time when the authorities are going to put their foot down and say hey, you've got to meet these expectations and like I said, if you think you've got problems, cruise ships are really going to be facing some major challenges. And the infrastructure requirements are just astronomical. So maybe there's an opportunity there to work a little bit more closely with the larger vessel requirements and come up with something that is standard. Obviously one of the other bigger challenges that I think your slide begged the question on, is the variation in those configurations from one country to another, and the vast disparity between the way those infrastructures are being set up. So hey, good luck guys.

Martin

Thank you Steve. One more final question from Lloyds.

Chris

I just have a quick comment on the compulsory aspects of the onshore power supply. It's been recommended at IMO that this not be compulsory, that the use of cold iron is not compulsory. And for the exact reason that some ports are miles away from a decent source of electrical supply. So what they've recommended is that there would be certain size limit vessels, there would be a lower limit to the size of the ship and to the power of the ship. And that's just a recommendation that's out there at IMO right now, so it's still sort of tossed up what size vessel we need to run from shore power.

Martin

Alright. We'll do a panel changeover now. I think my last sort of summary statement is that we need to buy more at anchor stabilisation systems, bigger generators, and bigger anchors. Thank you very much, panel. We'll see you later.