

Skipsteknisk: G.O. Sars: 99057

17<sup>th</sup> October 2001: Meeting in Oslo

## 1. EMI/EMC

Mr J R Pedersen, Technical Manager of Kjell G. Knutsen A.S, the EMC Project Manager for the G.O. Sars, made a businesslike presentation. This appeared to cover all the important aspects. The Quality Assurance Plan was very detailed indeed. He was confident that the company can meet the requirements given in the Appendix to the SOR.

Having been very recently introduced to this project, full technical details of the company's approach are not complete but the focus appears to be on electrical systems 'below sea level'. This should be satisfactory if levels in other areas are dealt with in proportion. From the scientific aspect, transducer cables are the most critical items to be protected and co-operation with Simrad and the yard will be needed to ensure the best possible arrangements are made for cable selection, trunking and routes. It is believed that the Simrad EK60 has improved noise immunity over the EK500 and that different transducer cables are now proposed (does Hans Petter know if this is correct?).

The company is reluctant to use filtering unless absolutely necessary and that is a good policy but there almost certainly will be places where some form of filter will be needed. It was agreed that the lab equipment would be the most susceptible to unwanted interference.

A questionnaire should be prepared ready for sending to prospective vendors of machines in order to ensure that they will have adequate performance. It would be preferable for this to be combined with the acoustic/vibration questionnaire.

Some updating of standards for EMI/EMC on ships has occurred since the Appendix to the SOR was written but there are no significant changes.

A test plan is to be developed soon and made available. This will need a critical appraisal.

## 2. UNDERWATER AND INTERNAL ACOUSTIC NOISE

DnV representative, Mr Abrahamsen is the Noise Control Project Manager. He and a colleague who is associated with vibration aspects gave progress reports on their work. It was confirmed that an independent assessor within the department will periodically check the work as part of the DnV Quality Assurance Programme.

The outline of a Noise Control Plan had been produced by DnV earlier this year and a copy was made available at this meeting. This showed a typical block diagram of the various stages to be followed in the project, some of which were examined in more detail later.

DnV's approach up to the present has been to concentrate on the propeller, generator sets, and propulsion motors as being the main noise sources and to

virtually ignore all the other machinery. Calculations are currently taking place on the paths from the main machinery to the water. Following discussion at the meeting it is expected that greater note will now be taken regarding the smaller items of machinery.

## 2.1. INTERNAL NOISE

DnV presented a Technical Report, called ‘Airborne Noise Analysis’, on their work in assessing the Airborne Noise (which includes structure borne levels). The report evaluation is said to be based mainly on statistical data from ‘similar’ ships. It is unlikely that any very similar ships exist in terms of machinery and layout so the analysis uses rather simple comparisons of dimensions and power.

It might have been expected that a detailed computer model of the vessel would have been employed to provide a thorough and detailed analysis with noise levels tabulated for each room space, related to frequency. This has been the procedure with Corystes and Scotia. The likely margin of error must be higher with the use of statistical data only, especially as it takes in such a variety of vessels so dissimilar to the G.O. Sars design.

The report summary implies that it will be impossible, and in some cases impractical, to meet the specified criteria. This statement is acceptable in some areas, e.g., the engine room (defined in the Appendix as a “Machinery Space (short term manning)”, where the predicted levels are between 101 and 111 dB and the criterion is given as 105 dB. Recent checking of notes shows that the level of 105 dB was intended to be measured at 1 m distance from the outer bulkheads of such Machinery Spaces, primarily the engine room. The purpose being to ensure that bulkhead cladding had to be used to create a reasonable environment within the area and to reduce noise transmission into the sea.

The table of levels should also have given a figure for a maximum level, i.e., the more central areas where 110 dB would be appropriate. DnV originally considered that no cladding was necessary in the engine room but have revised this idea and now state that a separate calculation is being done, which will be available later to show the effects of cladding.

No analysis of noise and vibration throughout the vessel when in the design stage and when the Appendix to the SOR was prepared so it was decided that a ‘blanket’ coverage under the heading “laboratories” would be used but split between the deck levels. Clearly, some laboratories are more sensitive than others and now that the overall analysis has been made, the levels for specific areas can be reviewed. The noise analysis is based on crude approximations so it must still be borne in mind that the margin for error is quite high.

It is widely recognised that noise in ships need to be reduced significantly and that the present levels advocated by the IMO are too high. These levels are currently being revised in line with the demands for greater comfort of sea goers. It is particularly important in a research vessel that non-regular sea goers can work and sleep without distraction from noise and vibration.

### Thruster Room

The 75 dB criterion was evidently based on some figures for a resiliently mounted noise reduced thruster with an air induced system in the tunnel. It seems clear from the DnV note that they now have figures for the actual thruster to be used, so their estimate of 95 to 102 dB must be accepted and the 'short term manning' criteria used.

### Wet Fish Sample Laboratory

Due to its situation this is the area where structure borne vibration could lead to a significant deviation from the 60 dB criterion and the DnV prediction is that levels of 70 to 79 dB could occur. *To put this into context, 60 dB is 5 dB greater than that which the sleep state of many individuals is disturbed, it is a typical level measured in a large and busy shopping area.* The maximum predicted excess is 19, say 20 dB at MCR which is ten times greater: levels will drop noticeably at lower loads/speeds. Considering the equipment/machinery likely to be used in the area 70 – 79 dB may not be excessive, although attempts should be made to keep levels near to 70 dB, i.e., 3 times greater than the 60 dB specified.

### Cold Store – Cold Climate Rooms

The relatively small excess levels predicted for these particular areas should not be a problem.

### Chemistry/Physics/Biology Laboratories

Further precautions will be taken to put these areas within the criterion of 60 dB.

### Net/Weld Workshop 2<sup>nd</sup> deck

Provided that the maximum predicted excess of 2 dB (a ratio of 1.26:1) is not exceeded, there should be no noticeable problem.

Dry Laboratory 2<sup>nd</sup> deck (analysis of plankton samples)  
Additional measures needed to fulfil the required criteria

Wet Laboratory 2<sup>nd</sup> deck  
Similar to above

Environmental Hanger  
60 dB is probably a reasonable aim for this area

Water Sampling Room  
There should be no problem in changing the criterion to 60 dB.

Operation Centre  
The predicted maximum excess of 1 dB is not significant but further examination of the area ought to be possible to meet the criteria with a small margin.

Electrical Mounting Laboratory  
As above

### Wet/Chemical Laboratory

Further measures should be possible to reduce the small excess.

### Geology Sediment Laboratory

As above

### Ventilation Systems

It is rightly pointed out that very rigorous noise control will have to be exercised for the ventilation and HVAC systems. The levels from these sources will need to be below the specified limits for the rooms. Instead of the 5 dB suggested, a figure of 6 dB (2 times) might be more appropriate.

### Inter-cabin Isolation

It was pointed out that no figures for this factor are given in the specification. As ship internal noise levels have been reduced, so the need for improved isolation between cabins and compartments has increased. Items such as CD players, radios and TV can cause severe irritation when heard in cabins adjacent to their location. No test has yet been devised for the purpose of measurement, which would need a sound projector of known characteristics over a specified frequency band. This would be placed in a cabin and measurements made of the noise levels detected in adjacent cabins. For the G.O. Sars we are relying on the statement, "Special attention should be given to inter-cabin isolation". The shipyard has a method of reducing the 'leakage' of sound through deck head junctions and this appears to have received approval from DnV. Isolamin or similar quality panelling will be used in the vessel.

### Vibration

The report says that the specification is rather diffuse regarding vibration but this is necessarily so. It is the duty of the shipyard noise consultants to take machinery vibration levels into account and to predict how these will excite, e.g., the hull plating and then decide if adverse effects will result and how these must be combated. If the noise control design will meet the main criteria for internal and underwater noise, sources of vibration are most unlikely to exceed the levels in ISO 6954 given as "adverse comments are not probable".

### Prediction of Noise Levels

This section of the DnV report goes into the theory of some aspects of noise reduction including what has previously been discussed in connection with internal levels. DnV assume that the HVAC vendor will control the noise from their system. There is a saying "Never Assume" and the yard will need to be reminded that a strict specification is required for this system and the ventilation.

DnV Report number 2001-0826 is quoted several times – have we received this report? It does not appear to be listed as such on any items received.

## 2.2. PROPELLER

DnV had advised the yard that their calculations were sufficient to show that the propeller design would meet the underwater noise requirements. This seemed to be a risky way to proceed but fortunately the propeller manufacturers will not guarantee results unless there are further model measurements to help prove their design and this work is understood to be going ahead. The new wake flow measurements from these test should prove useful for the overall assessment of propeller noise.

## 2.3. DIESEL GENERATOR SETS

Wärtsilä are providing the three generator sets using their 6L32 engines flexibly coupled to alternators supplied by Siemens. The yard were prepared to accept the supply of standard marine alternators with no special balancing and no vibration measurements during test,s so the characteristics would be unknown, but this was clearly unacceptable. Wärtsilä agreed their standard document on this matter does not specify that vibration measurements are required but said that they could not produce a satisfactory result unless a well-balanced alternator (hence low vibration) was used. Later, a sub-meeting was held between the yard, Wärtsilä and Siemens and it is understood that a satisfactory conclusion was reached on this issue. It would be useful to see what was decided between Wärtsilä, Siemens and the yard on this matter.

Wärtsilä reported that they have an improved design of genset raft for this project based on the experience gained with Scotia. The bedplate (or raft) will have a weight of 18 tonnes and the ratio of engine to raft weights will be 1:1. Rubber 'vee' mounts will be fitted from engine to raft and steel or rubber covers will be used to prevent contamination of the rubber in the mounts. From raft to hull there will be conical mounts. There is a need to check that the spacing of the mounts (600 mm) will coincide with frame spacing in the vessel. The main improvement needed over the Scotia results is a reduction in vibration transmission at engine running speed (16.7 Hz) and they believe it will be accomplished, even though the G.O. Sars running speed is lower (12 Hz).

Because of this, Wärtsilä have guaranteed the genset performance to the specification set by DnV (this guarantee is subject to a satisfactory performance from the alternators). Should the alternators fail to meet the necessary levels Siemens will have 30 days to achieve the specification. If they need to use the full 30 days there is still sufficient time to avoid delay to the build programme.

In Section (5.3.2), the diesel generators are dealt with in some detail and interaction between DnV and Wärtsilä is important on this matter. The term "engine feet" appears to be used to describe the baseplate, or raft. A description of the system gives the impression that both the engines and the alternators will be resiliently mounted, but in fact, the alternators will be hard mounted to provide maximum stiffening of the raft. This is in keeping with recent practice.

The matter of flexible pipe couplings is critical to the noise reduction measures. This is a matter where DnV should be taking the lead and recommending the most efficient couplings, bearing in mind that a number of requirements must be fulfilled. A compromise has to be reached between durability, attenuation, safety

and strength. The DnV report recommends rubber couplings and these will probably be the best attenuators, but will they meet the other criteria – some of which will have to satisfy the certifying authority? Armoured couplings have been decreed by Lloyds in some instances. These have a braided stainless steel covering over the pipe which reduces the attenuation considerably, they must be carefully fitted, with the bends correctly controlled. Wärtsilä are currently having some problems in meeting vibration specifications because of transmission through couplings. Should we assemble some information on materials and methods to pass on to DnV?

#### 2.4. PROPULSION MOTORS

A detailed vibration analysis of the propulsion motor assembly is being carried out by DnV at the moment in order to calculate noise radiated into the water. This is rather worrying because the yard has already signed, or is about to sign a contract with Siemens on the basis that they will supply motors to meet the tabulated data previously supplied by DnV. Presumably, the latter are not expecting any significant changes to arise from the current analysis. In the Technical Report DnV have given figures relating to octave bands, whereas the table evidently supplied to the yard (seen in the Siemens document) was in third octave levels. Some consistency in presentation would be preferred, although the conversions do tally.

Siemens are supplying TWMC propulsion motors and have stated that these will meet the specified vibration seating levels for hard mounted motors but they have not supplied proof. The failure to do so is based on a so-called classification issue but there is doubt as to whether this is genuine. DnV have stated that there will be, “Thorough test bed confirmation of compliance for the reduced power guarantee condition”. Although this would not seem to accord with the spirit of the specification, in strictly legal terms it probably does so. Previous motors for similar applications have met a vibration requirement at full speed.

The blowers will be acoustically isolated from the body of the motors. Tests of the motors, including vibration will be attended by DnV at the manufacturing plant in the U.S. Drives made by Siemens will be shipped over to run the machines for the tests.

No mention is made of the ripple frequency from the electrical drive. It seems that the armature will have a 24-pulse drive whilst the field will be fed from a 12-pulse drive. So it seems that there might be frequencies present at 1440 Hz and at 720 Hz. It is hard to predict what the overall result might be but the amplitude of these frequencies should be sufficiently low to avoid any ill-effects on the underwater noise levels.

It is interesting that DnV have shown the Ansaldo graph for the measured airborne noise levels of the propulsion motor fitted to Scotia. Difficult to see what relevance these figures have to the TWMC motors – for which it appears airborne noise levels will not be supplied!

## 2.5. AUXILIARY MACHINERY NOISE

Earlier impressions were that DnV had ignored the effects of smaller items of machinery but in 5.3.4 we see that some attention is given to this matter. What is missing is anything about the points that were raised at the meeting; the all-important questionnaires that should be sent to equipment suppliers. Only one example of problems arising from insufficient knowledge of small machine characteristics was given at the Oslo meeting but this should have served to highlight the importance of knowing what is being purchased in relation to what the specification requires. It would be preferable to combine this with the questionnaire on EMI/EMC matters.

## 2.6. UNITS FOR SPECIFICATION AND MEASUREMENT

DnV have used velocity as the basis for their specifications and were questioned about this. They maintain that there are no problems in measuring vibration using accelerometers with inbuilt integrators to give velocity readings instead of using the readings of acceleration directly. It is the practice in many parts of the world to specify and use acceleration for reasons previously given, but these do not have sufficient motive to insist that DnV follows the more modern practice. If problems do arise in the course of measurements onboard the vessel, accelerometers can be obtained and used.

## 2.7. OTHER MATTERS

### Assumptions

Under item 5.5 it is said that “secondary noise is primarily dependent on workmanship during construction”. It may not be enough to assume that the yard will see and note this item. A specific instruction and guidance would seem to be necessary on the various precautions to be taken.

### Appendix A

Floating Floors etc.

There is exhaustive coverage of the various materials and techniques available to reduce structure borne noise and vibration. These are matters to be dealt with between the yard and DnV and no comment seems necessary.

### Noise ranging trials

A list of equipment to be run during the noise ranging trials has been prepared by HI and will be made available.

Not enough is known about the relationship between underwater noise levels and vessel towing loads during trawling but the electrical loading should be carefully noted as each trawling run is carried out.

## 2.8. MATTERS TO BE FOLLOWED UP:

- a) Test Plan for EMI/EMC
- b) Copy of the Questionnaire to electrical equipment suppliers
- c) Copy of the Questionnaire to mechanical equipment suppliers  
Or a copy of the combined Questionnaire for (b) and (c) above
- d) Positioning/spacing of genset mounts
- e) Cladding calculations
- f) Strict specification for the HVAC vendor

- g) Flexible pipes and couplings
- h) Programme for inspections during construction
- i) Programme for inspection and witness tests of sub-contractor items
- j) Document needed from Siemens to confirm all electrical equipment meets EMI/EMC requirements
- k) Guidance to shipyard on control of 'secondary noise' as defined by DnV

#### COMMENTS

During the course of the meeting in Oslo the whole perspective of the project in terms of noise control and reduction was changed. What had previously appeared was either extremely scant information, or illogically based conclusions on the abilities of major contractors to satisfy the requirements. There was very little to indicate that DnV were competent to carry out the task of noise reduction and control.

Suddenly, they have produced evidence in the form of a verbal presentation and a written report to transform the situation, so we can have much greater confidence that these aspects of the project are moving in the right direction.

The fact that the internal noise predictions are based on a simple statistical model rather than calculation is still of some slight concern.

It was suggested that the keywords for the meeting and the future should be Communication and Cooperation. If these are put into practice it is hoped that no more crises will occur.

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