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THE DESIGN AND MANUFACTURE OF VESSELS IN SINGAPORE FOR NORTH SEA OIL EXPLORATION

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INTRODUCTION

The shipbuilding industry is one of Singapore's most important longstanding industries. The ships and oil rigs that are now being built include some of the most sophisticated that have ever been built there and comply with the most stringent overseas standards. The various criteria that have to be satisfied include the noise levels due to the need to rely on auditory signals when operating in dense fog as well as ensure the health of workers who live on the vessel for long periods at a time. This paper looks at some typical situations in the Singapore shipbuilding industry where noise control has been carried out for vessels intended for North Sea oil exploration. The regulations to be satisfied include that of the UK Department of Energy, Guidance on Design and Construction of Offshore Installations[1].

DESIGN CRITERIA

One of the first decisions that has to be made before starting a noise and vibration reduction program is to establish an acceptable design goal. This should be slightly lower than the final desired level, i.e. made more stringent, but not too much lower, because the cost of noise reduction increase rapidly as design goals are lowered, and the estimated cost may cause an abortion of the project before it is even started. They must be set somewhat below what is actually needed, however, to allow for small errors in measurement, differences in quality of acoustic materials, construction flaws and if a group of machines is involved, to allow for differences between machines.

The objective here may be to meet a certain predetermined noise level, such as that of the North Sea Oilfield Regulatory Bodies in this case. The design reference must be either the sound power or vibration level of the machine or the sound pressure or vibration level at a fixed distance from the machine. That is, the source must be specified and related directly to the machine and space which determines whether the criterion is for health aspects, interference with work, sleep or annoyance.

The U.K. regulations [1] states that the consideration of noise and vibration should form an integral part of the platform design. A design assessment of the noise and vibration characteristics of the vessel should therefore be carried out at an early state if only to satisfy this requirement for an offshore installation operating in the North Sea.

LIMITS FOR NOISE AND VIBRATION

Specified limits are amongst the first steps to be considered in bringing down noise and vibrations to design levels. In the North Sea oilfields, regulations include those of the U.K. Department of Energy, the Norwegian Petroleum Directorate, and others [3][4][5]. They state maximum permissible noise and vibration levels in workplaces; acceptable levels in the various other areas; and maximum permissible levels for certain restricted areas not

always accessed. The measured noise in these cases may be eventually produced by a single machine or by a combination of many kinds of machinery, for example in the engine room of the vessel.

If machinery noise reduction at the source is not feasible, for engineering or economic reasons, operators must resort to other techniques to comply with the required levels. For example, they can group machines together in less sensitive locations, or space them, or locate them remotely with respect to boundaries or the surrounding environment, using the appropriate shieldings where necessary. Noisy environments may be classified as such and the allowable duration of exposure appropriately indicated. Control rooms may be set apart from noisy areas.

PRODUCT NOISE AND VIBRATION EMISSION DATA

Manufacturer's product emission data, as the name indicates, offers a direct control over the final levels produced by a machine. These may simply state that the maximum noise or vibration level radiated by a machine does not exceed a certain level when the quantity is measured according to a prescribed test code [6]. Measured noise may be stated in terms of overall A-weighted sound pressure levels, octave-band sound pressure levels, one-third octave-band sound pressure levels, or a combination of these, all measured at a fixed distance from the machine, under known or measurable room conditions, as specified by the manufacturer.

Maximum noise emission may also be stated in terms of sound power or sound power level which are independent of distance from the machine and independent of room environment [7]. More and more such specifications are being required by local designers, in order to prepare estimated resultant noise levels. Although Singapore does not yet have a standard for product noise emission, product data for equipment from many overseas suppliers may be obtained quickly when requested. A popular rating, one easily measured by the manufacturers, is the overall A-weighted sound pressure level, measured at a fixed distance from the machines, in a given environment.

NOISE AND VIBRATION LEVEL ESTIMATION

Vibration minimisation is ensured by the traditional spring and base design whereas for noise control purposes an estimation of the noise level is obtained from sound insulation and absorption calculations. It is obvious that measured sound pressure levels are affected by the environment where the machine is installed, and that this effect must be either calculated or measured in order to adjust measured sound pressure levels to some standardised condition, such as in the free-field. Airborne sound insulation is relatively easy to control using appropriate partition panels and doors.

Unfortunately, most machinery in offshore vessel are installed in very reverberant locations where it is difficult to minimise reverberant sound power. Any sound absorbant material use has to satisfy fairly stringent fire regulations for these vessels.

PROBLEM AREAS

Typical noise sources for an offshore vessel include electric motors, diesel generator sets, fans, compressors, valves, piping, air-conditioning equipment, hoists, cranes and pumps. Although other equipment can also produce high noise

levels, they are usually less numerous or are located in areas not generally occupied by personnel and not likely to be a source of compliant, e.g. the mud pump room located well down in the pontoons.

Once these sources are identified and quantified, noise control measures can be applied, either at the source or using sound absorption or insulation. It is emphasised at this point that the use of ear protectors for the protection of hearing of workers [8] [9] should be relied upon only as a last resort and even then, considered as a temporary measure pending other treatment in areas such as the engine rooms which may be regarded as restricted access areas.

OPERATION IN NORTH SEA OILFIELDS

A mobile offshore installation is required to comply with the requirements leading to the aware of the certificate of fitness to enter territorial waters of the various national sectors. Compliance with the regulations and guidance notes in the U.K. includes the carrying out of a design assessment of the noise and vibration characteristics of the vessel. The design assessment on noise and vibration should include a general arrangement plan of the platform together with a description of the methods used including insulation drawings etc., to reduce the noise and vibration levels. An estimate of the expected noise levels is also considered beneficial but not strictly required. Noise and vibration measurement surveys for both new installations and those entering U.K. waters for the first time may be carried out when the installation becomes operational in these waters for the first time [10]. Such measurements were carried out during sea trials in Singapore after the vessels were built in order to ensure compliance with the levels specified upon entering U.K. waters.

NOISE CONTROL APPLICATION IN OFFSHORE INSTALLATIONS

The lowest fundamental noise limit is based on hearing damage risk considerations and may be derived from the requirements of the U.K. Department of Employment's Code of Practice for Reducing the Exposure of Employed Persons to Noise [9]. If shift lengths are less than 12 hours then the noise limit may be increased in accordance with this code of practice, i.e. a noise limit of 90 dB(A) will apply for an eight-hour shift. These limits generally apply for broad band noise. Where a noise exhibits dominant tonal characteristics, then it is desirable to suppress such characteristics. In the exceptional case where extremely large and noisy machinery is operational, ear protectors must be used but only as a last resort.

Where reliable speech, telephone or radio communication is required, or demanding mental tasks must be performed, then the noise limits for these areas should be considerably less than the limit for general work areas. Recommended noise limits for particular work areas such as control rooms, etc., are given in Table 1. Any tonal characteristic should be suppressed so as not to give rise to annoyance. These limits refer to background noise, including ventilation and external noise sources, but not to manually controlled operations involving inherently noisy equipment, e.g. drilling for which general work area noise limits shall apply. This does not include the radio/communications room in which noisy office equipment, e.g. telex machines, should either not be installed or should be suitably quietened. Noise from airconditioning using designed cooling and ventilation parameters and fans should be examined for the quiet areas where a low background noise level is specified.

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Table 1 Typical recommended noise limits for specific work areas of offshore installation

Specific work areas of offshore installations	Noise limit dB(A)
Workshops	70
General stores	70
Kitchens	60
Control room	55
Offices	55
Laboratories	55
Radio/Communication rooms	45

For other areas of the installations, noise levels to be designed for are shown in Table 2.

All reasonably practicable means should be taken to comply with the specified noise levels. If the limit cannot be achieved in certain areas such as in the engine room, then these should be treated as 'restricted' and appropriate warning notices posted. Personnel entering these areas should generally be obliged to wear suitable ear protectors unless their daily unprotected noise exposure can be shown to be within the requirement of the levels specified.

Other examples of restricted areas could be as follows:
(a) Normal operational condition eg. within noise control enclosures large enough to admit service personnel.

(b) Intermittent operational conditions: on the helideck when a helicopter is present.

Table 2. Typical recommended noise levels on board off-shore installations

Location	Noise Limit (dBA)
Messrooms	55
Music	50
TV Room	50
Reading Room	50
Gymnasium	50
Cinema	45
Passageways	60
Change Room	60
Sleeping Cabins	45
Departure Hall	55
Hospital	45
Treatment Room	45
Conference Room	45
Engine Room	100
Emergency Generator Room	110

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TYPICAL MEASUREMENTS

Measurements made during sea trials of a typical offshore installation indicated acceptable vibration and noise levels. These measurements were made with all machinery in operation and the results are shown in figures 1-2.

CONCLUSION

It will be seen from the above that acceptable noise and vibration levels have been achieved for the platforms fabricated in Singapore. Suitable levels are achieved for the different criteria requirements, for the health of workers, the acceptable environment for rest as well as for recreation on board the vessel. By satisfying the various national regulations the platforms are able to operate in any oilfield from the North Sea to the South China sea.

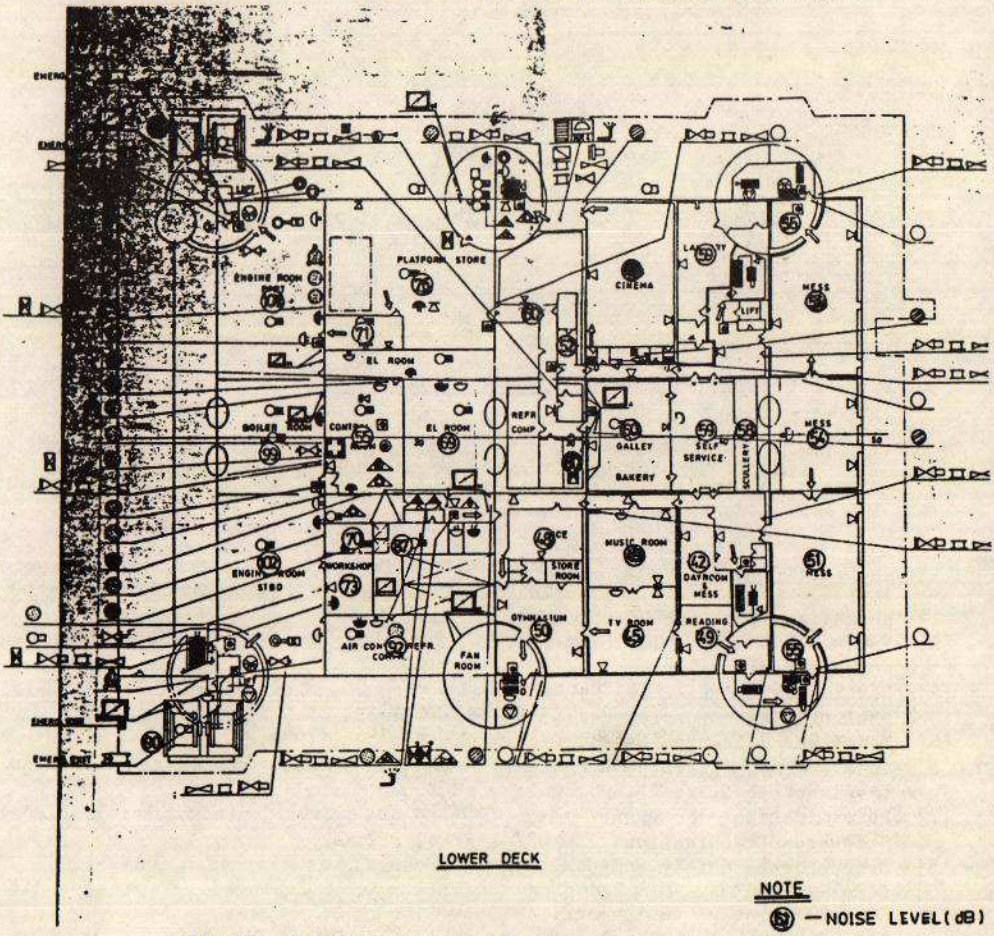

Fig. 1 Typical noise levels measured on lower deck

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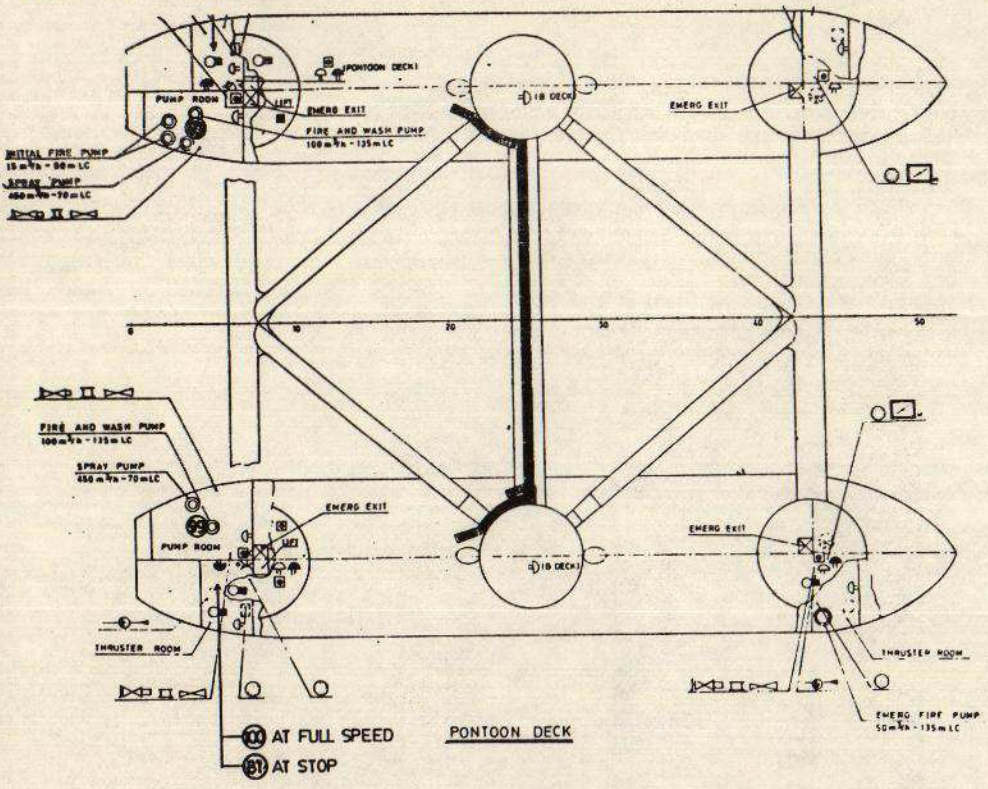

Fig. 2 Typical noise levels measured on pontoon deck

REFERENCES

[1] UK Department of Energy, Guidance on Design and Construction of Offshore Installations, Part II, Section 5.9 Noise and Vibration, HMSO 1977.
[2] Norwegian Petroleum Directorate, Section 7.
[3] National Swedish Administration of Shipping, S.S.V., Guidance Notes on Noise and Vibrations.
[4] Norms for Admissible Noise Levels on Seagoing Vessels, USSR Chief Sanitary Inspectorate, 24/IX/1962 No. 416-62.
[5] Noise and Vibration Notes, Det Norske Veritas, 1981.
[6] Telex message from Nohab Diesel Company regarding Noise and Vibration Levels of the five 21,000 kg 1850 kW Nohab Diesel Engines.
[7] Determination of Sound Power Levels of Noise Sources, International Standards Organisation, ISO/D3741-3746, 1976.
[8] Occupational Safety and Health Act, Occupl. Noise Exposure, USA, 1968.
[9] Code of Practice for Reducing the Exposure of Employed Persons to Noise UK Department of Employment, HMSO 1872.
[10] From Correspondence with U.K. Department of Energy, Petroleum Engrg. Div. 1981.