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Motion Sickness Incidence (MSI) Prediction on 80 M LNG Ship Carrier

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ABSTRACT: The motion of ships is move up and down or shocking on the high seas caused by large and continuous waves can cause symptoms of illness in the form of dizziness, nausea and even vomiting which is often termed as seasickness (sea sickness or motion sickness). In this research, a study was conducted on the results of calculations and simulations of the vertical acceleration of the LNG ship's movement so that it could be seen the performance of the ship on crew comfort. Overall Motion Sickness Incidence (OMSI), is also presented as one of the outputs for this crew comfort level prediction, where in this OMSI calculation uses 3 different sea-states and also in each sea-state it is simulated with 3 types of periods (Tz) at service speed (Vs) 20 knots. ISO 2631 standard states seasickness is not experienced at speed 20 at 45, 135 or 180 degrees. After 8 hours, seasickness occurs when hit by 90 degrees. Moderate water conditions and rough water do not cause motion sickness at 0 and 45 degrees.

KEYWORDS: LNG Ship Carrier, MSI, Period, Wave Water

I. INTRODUCTION

Gas and liquefied natural gas (LNG) markets saw a level of volatility in 2020 that had never been seen before. The number of vehicles on the road used less petrol, which was down 3 percent. The demand for LNG was more resilient than expected, and it even managed to expand by one percent. Nevertheless, the LNG market saw significant levels of volatility during the course of the year, with severe oversupply and extreme tightness at various points throughout the course of the year.

From 2020 to 2035, the use of petrol as a fossil fuel is projected to rise by 0.9 percent, making it the fastest-growing of all fossil fuels. It is the only fossil fuel that is anticipated to continue growing in use beyond 2030, reaching its peak in 2037. It is projected that there will be a 0.4 percent drop in demand for petrol between 2035 and 2050. This relatively low fall is owing to the hard-to-replace gas usage in the chemical and industrial sectors, which reduces the effect of an accelerated decline in gas used for power generation.

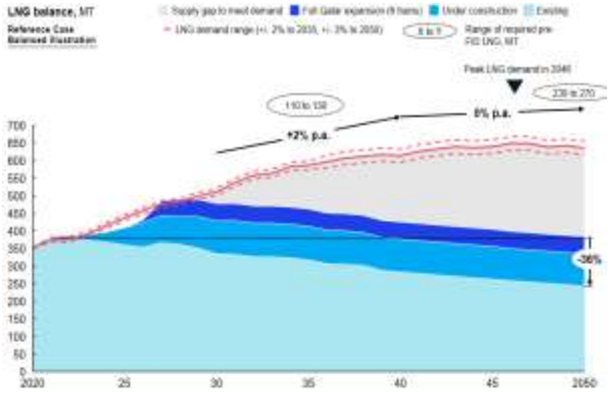


Figure 1. Global LNG need.

Potential for 230 to 270 MT of new LNG capacity required by 2050. Demand growth is flat over the period from 2040 to 2050 but with new capacity required tooffset declines from older legacy projects.New supply expected to be overwhelmingly concentrated from the US, with smaller contributions from Canada, Russia, East Africa and potentially the Middle East.

Indonesia is a country that has a lot of natural products that can be utilized or processed properly. One of the natural products in Indonesia is natural gas, natural gas is processed and used as a basic fuel for cooking as well as fuel for vehicles or transportation in general. Natural gas is obtained by drilling, both in the middle of the sea and on land, the natural gas that has been extracted or obtained will be distributed to the material processing site and then to the place where it will be supplied. Natural gas is usually distributed with the help of sea transportation if the destination is far away and crosses the island. The means of sea transportation used to transport natural gas are LNG ships or LNG carriers.

LNG Carrier is a high-tech ship specifically used to transport cargo in the form of liquefied natural gas. LNG ships are designed with high enough technology so that seakeeping calculations are needed to determine the ship's manoeuvrability characteristics if the ship is in a high enough wave condition to maintain cargo so as not to cause significant movement which could result in the ship being in a condition or condition that is too high. dangerous or emergency. Seakeeping (ship motiont) is a field of study that includes the behavior and performance of ships on waves that show the ship's ability to maintain functions in carrying out its mission at sea. Seakeeping is divided into 6 (six) states, namely rolling, pitching, yawing, heaving, surging, swaying that affect MSI (Motion Sickness Incidence).

Motion sickness incidence refers to the commonly used phrase that describes the experience of discomfort and vomiting resulting from several forms of motion, such as those encountered on ships, aeroplanes, autos, agility games, in zero-gravity environments (such as space), and in ifts. Additional manifestations include yawning, erratic respiration, somnolence, cephalalgia, and a sense of apathy towards the well-being of others. Ultimately, the aggregation of these symptoms often leads to the occurrence of emesis. Studies have been conducted in both maritime and laboratory settings to investigate the impact of ship motion, including roll, pitch, and heave, as well as the frequency, acceleration, and duration of these movements.

Seasickness, or motion sickness aboard ships, refers to a collection of painful physical symptoms brought on by the motion of the ship, including trouble breathing, dizziness, nausea, pallor, and vomiting. When medical attention is required, passengers or staff members may be hospitalised. The human brain becomes seasick when the stimuli it gets from the labyrinth of the eyes and ears do not match up in terms of excitability or conformance. Those who are susceptible to seasickness often find themselves on enclosed decks, where they are unable to detect any motion.

Simultaneously, the ear labyrinth reacts to the ship's motion, creating a discrepancy between the sensations received by the eyes and the ear labyrinth (responsible for bodily balance), leading to feelings of dizziness and nausea. The vertical acceleration of the ship is calculated and simulated at various locations. The proportion of passengers that become seasick or suffer motion sickness incidence (MSI) may be affected by the measuring location, duration, and direction of the waves, as shown in the simulated results. Ships' movement causes motion sickness incidence (MSI), commonly known as seasickness, which causes trouble breathing, dizziness, nausea, paleness, and vomiting. In extreme circumstances, passengers or personnel must be hospitalised.

This research was conducted with a case study of Motion Slackness Incidence which aims to find out how the MSI is on the bow of the ship when sailing in the waters of an LNG carrier with an average wave height of 2 meters. The analysis was carried out with the help of Maxsurf motion to obtain the MSI when the crew worked in the LNG ship deck area

II. METHOD

A. Ship Geometry

In this study the model will be analyzed using Maxsurf Motion Advance software to get Moti on an 80 meter LNG ship. The following are the main sizes of the ships used, with the following details.

Figure 2 LNG Ship Carrier

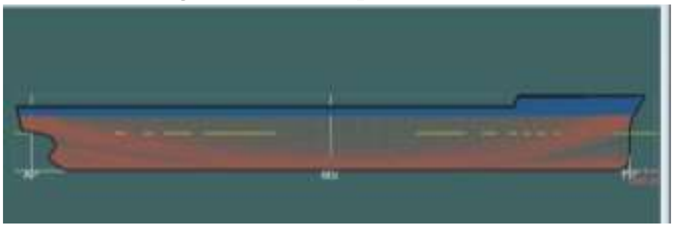


Figure 3 LNG Ship Carrier Desain

Tabel 1. Particular Dimension of LNG Ship Carrier :

LOA	80,5	m
LWL	76,5	m
B	13,5	m
H	9	m
T	4,572	m
Vs	20	Knots

On this 80-meter LNG vessel, there are 3 locations for measuring locations, namely the AP deck point, the midship deck point and the FP deck point. Table. 2 shows the details of the distance and position of the remote location to the CG. Meanwhile, Figures 4 and 5 show the remote location points on the ship model in Maxsurf Motion

Table 2. Measurement location/remote location on an 80 meter LNG ship.

Name	Long. Pos	Offset	Height	Long. Pos From CG	Height From CG	MII Slide Friction Coeff.	MII Tip Fore/Aft. Stance	MII Tip Side/Side Stance
AP of Ship	-78,46	0	7,75	-40,28	3,18	0,7	0,17	0,25
Midship	-40,3	0	7,75	-2,12	3,18	0,7	0,17	0,25
FP of Ship	-2	0	7,75	36,18	3,18	0,7	0,17	0,25

Figure 4. The position of the remote location seen from the side (side view).

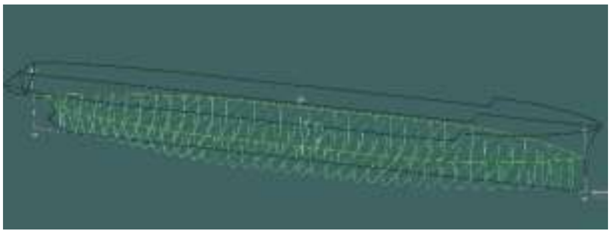


Figure 5 The position of the remote location from a perspective.

B. Wave Spectra

The significant wave height (Hs) and the zero-up crossing period (Tz) are two characteristics of the wave spectrum. The JONSWAP spectrum is a useful representation of the spectrum. Hasselmann discovered Pierson-Moskowitz to be a contributing element in the developed spectrum by analysing data from the Joint North Sea Wave Observation Project, or JONSWAP. To calculate the JONSWAP spectrum, we multiply the Pierson-Moskowitz spectrum by the peak enhancement factor γ^r. Equation 4 shows the Pierson-Moskowitz spectrum.

$$S_{(PM)} = \frac{Hs^2}{4\pi}\left(\frac{2\pi}{Tz}\right)\omega^{-5}\ exp\left[-\frac{1}{\pi}\left(\frac{2\pi}{Tz}\right)^4\ \omega^{-4}\right] \quad (1)$$

Where $S_{(PM)}$ is the Pierson-Moskowitz wave spectrum in m^2/(rad/s), Hs is the significant wave height in meters, Tz is the zero-up crossing period in seconds, and ω is the wave frequency in rad/s. Then Pierson-Moskowitz is given a curve in the wave frequency function.

JONSWAP spectral formulations have been more popular in recent years for application in the design and study of offshore constructions in Indonesia. Some research, however, suggests using values closer to 2.0 to 2.5 in Indonesian seas. The goal is to lessen the weight of energy that comes from a narrow range of wave frequencies. Equation 5 displays the results of this operation.

$$S_{(JWP)} = S_{(PM)}\gamma^r \quad (2)$$

Where $S_{(JWP)}$ is a JONSWAP wave spectrum, γ is a peak enhancement factor where the value for Indonesian waters is 2 to 2.5, r is formulated with $r = exp\left[\frac{(\omega-w_0)^2}{2\,\tau\,\omega_0{}^2}\right]$, ω_0 is the wave peak frequency and τ is a shape parameter with 0.07 if $\omega \le \omega_0$, and 0.09 if $\omega > \omega_0$.

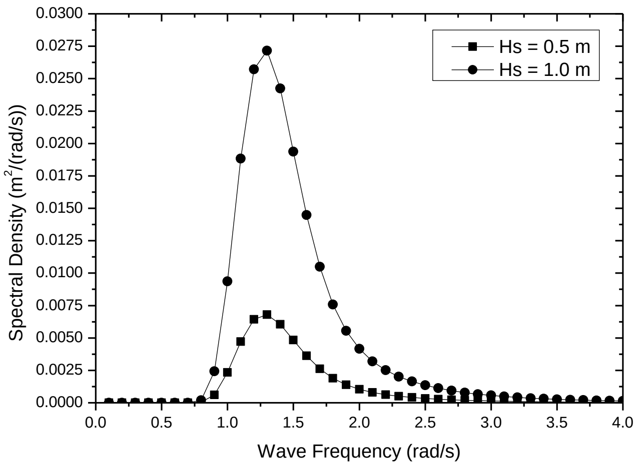


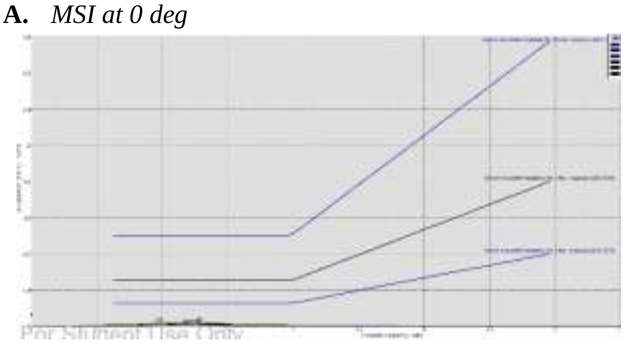
Figure 6. Zero up crossing time for JONSWAP waves is 3.5 seconds, and the wave height varies between 0.5 and 1.0 metres.

Figure 6 shows that the spectral density of waves with a height of 1 metre is larger than that of waves with a height of 0.5 metres, which makes sense given that the energy produced by the waves increases with increasing wave height. Moreover, the graph reveals that the maximum energy of a zero-up crossing lasting 3.5 seconds occurs at a wave frequency of 1.0 rad/s to 1.6 rad/s, suggesting that a ship operating at this frequency may be able to achieve a satisfactory motion response. Furthermore, it is clear that the spectral density is low both for low and high frequency waves.

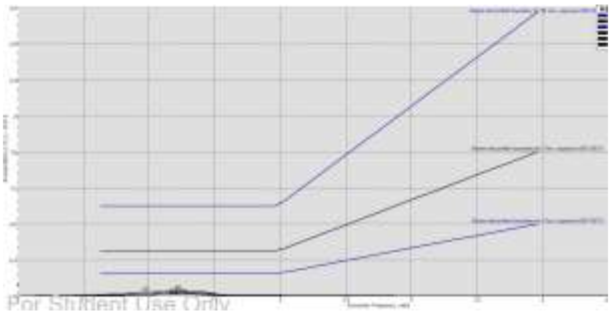
III. RESULT AND DISCUSSION

Motion sickness incidence is the standard term for discomfort and vomiting caused by various conditions of movement: on ships, in airplanes, in cars, stunt games, under zero gravity pressure (space) and in elevators/lifts.

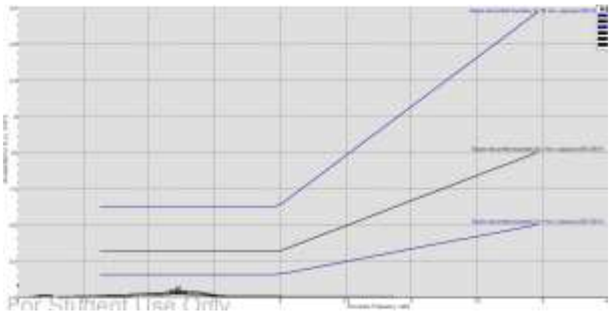
A. *MSI at 0 deg*



(a) Tz = 4,294 s



(b) Tz = 6,846 s

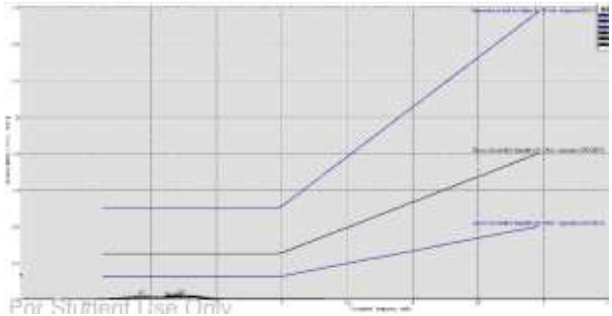


(c) Tz= 9,018 s

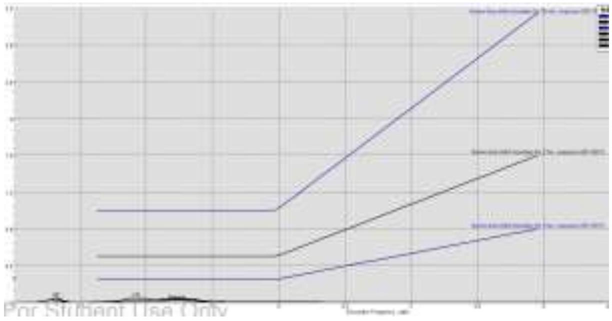
Figure 7 MSI Simulation at 0 deg

Dari gambar ketiga grafik di atas pada 20 knot, 0 deg following seas tergolong nyaman disemua modal periode.

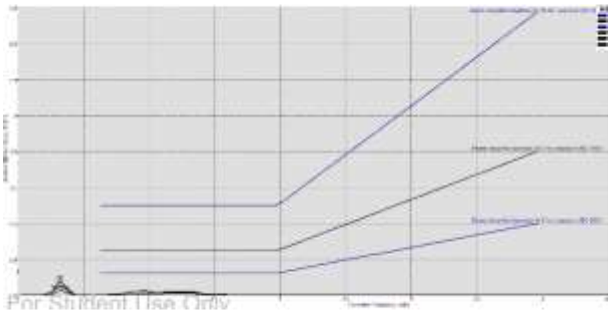
B. MSI at 45 deg



(a) Tz = 4,294 s



(b) Tz = 6,846 s

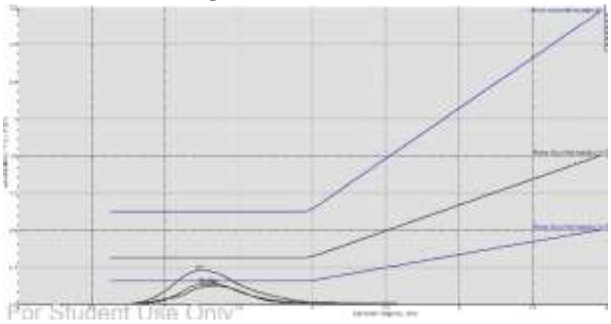


(c) Tz= 9,018 s

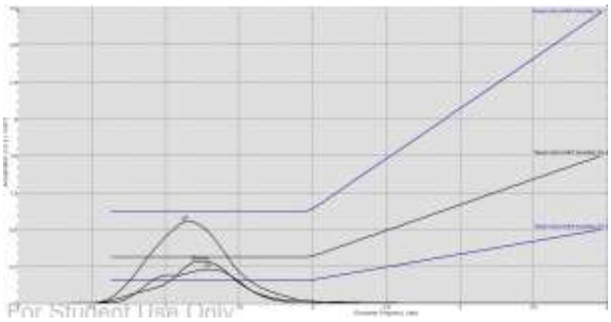
Figure 8. MSI Simulation at 45 deg

From the three graphs in Figure 8 above at 20 knots, 45 deg (quartering seas) is considered comfortable in all capital periods.

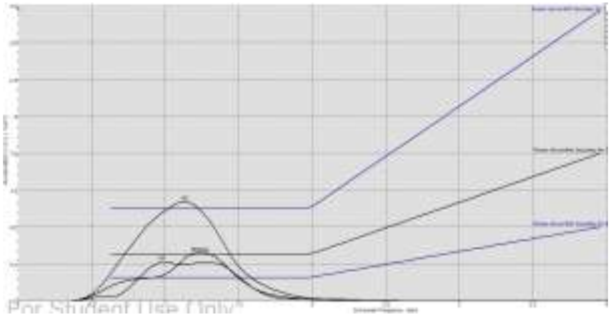
C. MSI at 90 deg



(a) Tz = 4,294 s



(b) Tz = 6,846 s

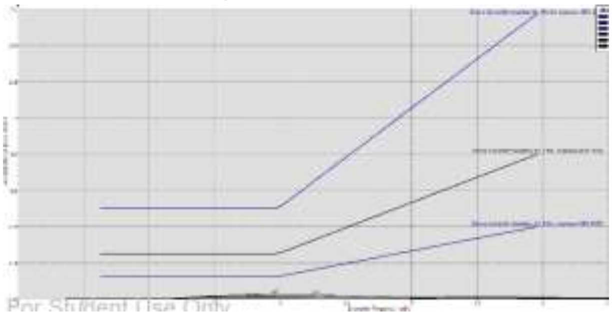


(c) Tz= 9,018 s

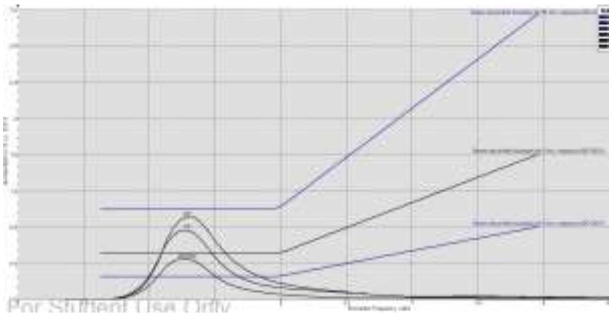
Figure 8. MSI Simulation at 90 deg

From the three pictures above, at 20 knots, 90 deg beam seas, on the capital period of 4,294 s, there was discomfort only on the AP deck after 8 hours of sailing, on the capital period of 6,846 s, there was discomfort on the AP deck after 2 hours of sailing, for Midship and FP uncomfortable for 8 hours. The capital period of 9.018 shows discomfort on the AP after a 30 minute cruise with an encounter frequency of 1.136 rad/s at an acceleration of 1.078 m/s^2, on Midship and FP there is discomfort after a 2 hour cruise.

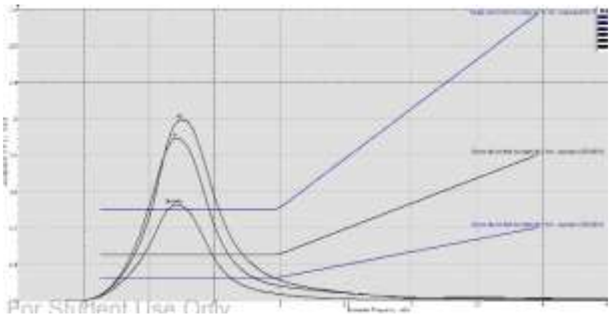
D. MSI at 135 deg



(a) Tz = 4,294 s



(b) Tz = 6,846 s

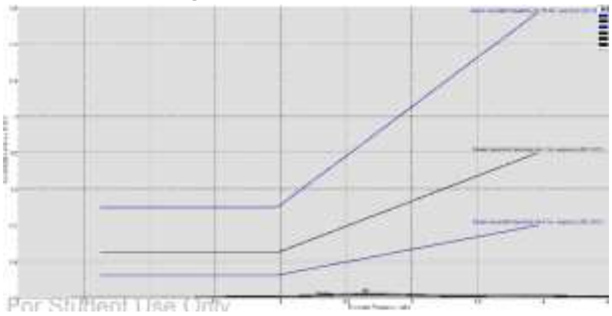


(c) Tz= 9,018 s

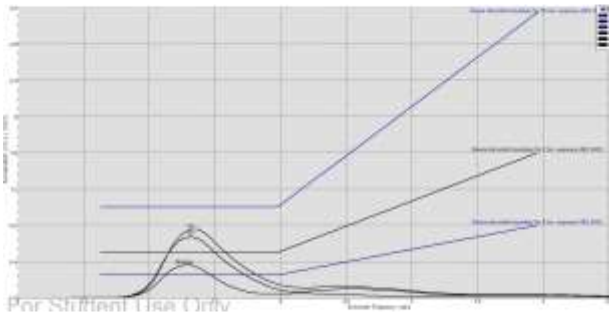
Figure 8. MSI Simulation at 135 deg

From the three graphic of Figure 8 above, at 20 knots, 135 deg quarter head seas, for a capital period of 4,294 s it was relatively comfortable, for a capital period of 6,846 s there was discomfort on the AP and FP decks after a 2-hour cruise, for Midship there was discomfort after an 8 hour cruise. The capital period of 9.018 shows discomfort on the AP after a 30 minute cruise with an encounter frequency of 1.136 rad/s at an acceleration of 1.078 m/s^2, on Midship and FP there is discomfort after a 2 hour cruise.

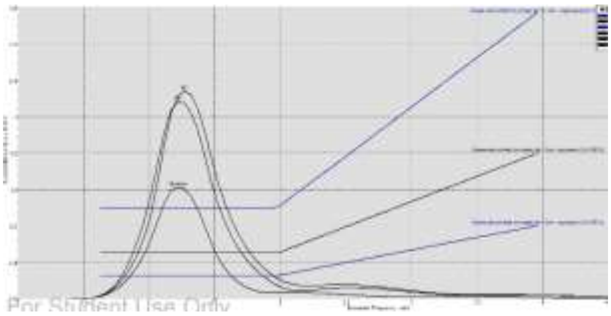
E. MSI at 180 deg



(a) Tz = 4,294 s



(b) Tz = 6,846 s



(c) Tz= 9,018 s

Figure 9. MSI Simulation at 0 deg

Figure 9 shows MSI simulation at 20 knots, 180 deg heading seas, during the 4,294 s capital period it was relatively comfortable, at 6,846 s capital period there was discomfort on the AP and FP decks during the 2 hour cruise, for Midship there was discomfort after the 8 hour cruise. The capital period 9.018 shows discomfort on all decks after 30 minutes of sailing with an encounter frequency of 1.271 rad/s at acceleration of 2.285 m/s^2 on AP, encounter frequency of 1.218 rad/s on acceleration of 1.226 m/s^2 on Midship, encounter frequency 1.218 rad/s at acceleration 2.164 m/s^2 at FP.

CONCLUSIONS

Based on the simulations that have been carried out on the 80-meter LNG ship model, the analysis can be concluded as follows:

1. In the study, the predicted results of motion sickness incidence at each remote location were obtained, from

the analysis results the greater the MSI when on sea-increasingly extreme state.

2. Referring to the ISO 2631 standard, at speed 20 there is no seasickness at 0, 45, 135, 180 deg waves. However, when hit by a 90 deg wave, seasick discomfort occurred after 8 hours of sailing. for a speed of 20 knots in slight water conditions it is predicted that no crew will experience seasickness, if moderate water conditions and rough water do not experience motion sickness at 0 and 45 deg, for 90, 135 and 180 it is certain that they will experience seasickness.

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