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Port Authority of New South Wales
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Attention: Ryan Bennett
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Dear Ryan

White Bay Cruise Terminal
Ship Noise Control by Shore Based Power

Introduction

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by the Port Authority of New South Wales to review the potential reduction in noise levels when Cruise Ships berthed at the White Bay Cruise Terminal (WBCT) are operated using shore based power. The noise assessment has been based on the *Pacific Jewel* vessel, being typical of the vessels that berth at the WBCT. A 3D computer noise model of the vessel has been used which includes significant noise sources, as based on nearfield measurements and manufacturers data. The model has then been used to predict noise levels under normal operation and shore based power. It should be noted that, similar to the vast majority of cruise ships worldwide, the *Pacific Jewel* is not equipped for shore based power.

Ship Operation at Shore

The *Pacific Jewel* is typical of the cruise liners that berth at the WBCT, with four (4) diesel driven generators (DDG) of approximately 8 MW capacity each to provide all power for the vessel. The DDGs are located at a lower deck level, and there is an additional emergency DDG above the waterline not used or tested when in port under normal operating conditions. When berthed one (1) DDG will be operational to provide electrical power for ventilation, air-conditioning, lifts etc. Directly associated with the DDG operation are combustion air fans (one dedicated for each DDG), DDG room exhaust mechanical ventilation (four installed on variable frequency drives (VFD)), and DDG room comfort supply mechanical ventilation also installed with VFDs. Other general ventilation equipment, such as galley exhaust and passenger area ventilation and air-conditioning etc will operate independently of the DDG(s) and their associated ventilation equipment.

The provision of shore based power via an electrical connection to the vessel will enable the DDG to be turned off. The DDG combustion air fans would also be turned off, with other systems including the general ventilation and air-conditioning equipment operating normally. Whilst no DDG would be operational, the DDG room comfort supply and DDG room exhaust mechanical ventilation would continue to operate in automatic mode, however, given the reduced heat load at reduced capacity.

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Noise Modelling and Results

A 3D computer model was used to predict noise levels at the nearest residential receiver in Grafton Street. At this location noise monitoring surveys have measured the *Pacific Jewe*l LAeq noise level at 50 dBA on two occasions, and this will be the assumed ship noise level with a single DDG operational.

The noise model consists of all significant noise sources with the model calibrated to the 50 dBA measured noise level. To determine the individual sound power levels (SWLs) for significant sources near field measurements were conducted where access to source, such as the supply and return air louvres was possible. Additionally, reverberant noise level measurements of the DDG exhaust fans were conducted within the ship funnel to estimate the SWLs of the DDG exhaust fans. Where access was not possible, such as the elevated DDG engine exhausts, then SWLs were estimated based manufacturer's for similar sized diesel engines and the insertion loss provided by absorptive mufflers.

Specific operational parameters (volume and static pressure) for the operation of the DDG exhaust room fans and DDG comfort fans when the ship is supplied by shore based power are not available, and for this study are assumed to range from 5 dB to 10 dB below that when operational for a single DDG operation.

Predicted noise levels for the significant noise sources are presented in **Table 1** for DDG (normal) and shore based power operation.

Table 1 Contribution of Noise Sources at Grafton Street - Normal Operation

Ship Noise Source	Estimated Grafton Street Noise Level – DDG Operation	Estimated Grafton Street Noise Level – Shore Based Power
DDG exhaust room fans	40 dBA	30 to 35 dBA
DDG combustion air supply fans	36 dBA	Off
DDG engine exhaust	48 dBA	Off
All other sources	40 dBA	39 dBA
Total	**50 dBA**	**40 to 41 dBA**

The 50 dBA measured noise level from the *Pacific Jewel* has been previously analysed to determine the low frequency content of the noise in response to vibration complaints. The analysis indicated the *Pacific Jewel* noise contained low frequency noise, and the source of this low frequency noise is expected to be from the DDG exhaust, the exhaust room fans and the combustion air supply fans. Accordingly, by switching off the DDG and the combustion air supply fans, and running the exhaust room fans at reduced capacity the low frequency noise will be reduced. The reduction in dB will be by at least the overall reduction in the A-weighted noise level.

Comparison with Potential Alternative Mitigation Solution - Noise Wall

SLR has previously conducted a study into the effectiveness of reducing the noise level from vessels berthed at the WBCT using a noise wall on the southern side of Grafton Street. The study concluded a noise wall along Grafton Street of height 11.5 m would provide typically an 8 dB reduction in noise and a 15.5 m noise wall, typically 16 dB for residences on Grafton Street. However, residences to the west of Adolphus Street and those in Cameron's Cove would receive limited benefit as the wall provides negligible shielding to these areas. The noise wall cost would be of the order of $2.5 – 4 million, dependant on height. In comparison, the cost of shore power is estimated to be of the order of $36 million for the shore facilities and the additional cost estimated to retrofit the fleet currently calling at WBCT is in the order of $27 million.

Summary

SLR has been commissioned by the Port Authority of New South Wales to review the potential reduction in noise when vessels at the WBCT operate from shore based power. The study has been based on the *Pacific Jewel*, which is a typical vessel that uses the WBCT. The predicted noise level reduction is therefore specific to the *Pacific Jewel*, however it should provide an indication of that likely from similar vessels berthed at the WBCT under shore based power, noting that every ship will be different in terms of the potential noise reduction, and that not all vessels currently have the ability connected to shore power.

Noise levels from the *Pacific Jewel* have been measured to be 50 dBA, at the nearest receivers to the WBCT in Grafton Street. The provision of shore based power will enable the DDG to be shut down and the associated mechanical ventilation systems either switched off or reduced in capacity. The resultant noise level at the nearest receiver is predicted to decrease by an estimated 9 dB to 10 dB.

In comparison to a noise wall as a mitigation option, shore power provides a similar reduction in noise level and could be considered more effective, as the noise wall would not reduce levels at residences to the west of Adolphus Street, or at Cameron's Cove. However, the provision of shore power facilities to WBCT is an order of magnitude more expensive and is limited by the number of vessels that have or would be required to have capability to accept shore based power.

Yours sincerely

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Principal