Cabins Noise Control on the Large Oil-tanker

Wu-Wenwei[1,2] Li-Zecheng[1,2]
(1. China Ship Scientific Research Center, National Key Laboratory on Ship Vibration & Noise, Wuxi 214082, China; 2. Jiangsu Key Laboratory of Green Ship Technology, Wuxi 214082, China)

Abstract

With the revision of the code on noise levels on board ships and the proposed of the implementation requirements by IMO, ship cabin noise has become an important factor during the design and construction of the ship. In this paper, for the arrangement of the main noise sources and the typical cabins of the large tankers, the impacts of the main noise sources and structure-borne noise transmission paths on the cabins noise of oil-tanker have been analyzed, and constructive suggestions have been put forward.
Keywords: Noise levels, Cabin, Floating floor, Oil-tanker

1. Introduction

As an important vehicle in present, ship has many advantages which can’t be exceeded by other vehicles. Recently, with the integration of the world economy, transportation at sea is more and more busy. At the same time, problem of noise disturbance on board ship gets more attention of international society. As we know, in Nov. 2012. The DRAFT CODE ON NOISE LEVELS ON BOARD SHIPS has been adopted by MSC91 to provide international guideline for protection against noise regulated by regulation [II-1/3-12] of the International Convention for the Safety of Life at Sea (SOLAS).
According to the new specification, the vessel shall comply with the noise requirements as specified in the SOLAS II-1/12. The new specification states that the noise levels during operating condition shall be measured at normal sailing condition with the main engines at service speed (not less than 80%MCR). The noise level limits are shown below.

Work area：	
Engine workshop	85 dB(A)
Engine control room	75 dB(A)
Main engine room	110 dB(A)
Drive area：	
Wheel and chart room	65 dB(A)
Communication room	60 dB(A)
Dwelling district：	
Inside bedroom and sickroom	55 dB(A)

Mess room	60 dB(A)
Gymnasium	60 dB(A)
Office	60 dB(A)
Kitchen	75 dB(A)

The prediction of noise onboard ship may be useful for new oil-tanker design in understanding what kind of noise control measures might be effective and if cabins noise levels are able to comply with the noise requirements. FEM and SEA models may be used to analyze the noise sources, the noise transmission paths, and estimate cabin noise levels onboard ship. This analysis can help to choose and optimize noise control measures, and improve the level of control.

.

2. Analysis Method

The analysis scheme for cabin noises onboard ship is shown in Fig1.

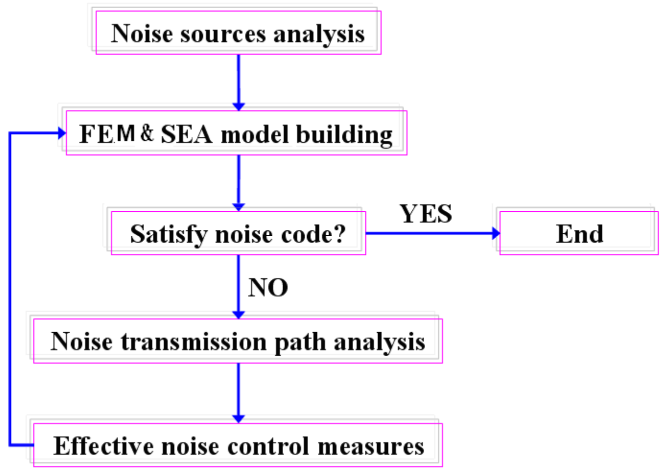

Fig1 Analysis scheme

2.1 Noise Sources Analysis

Propeller cavitations and pressure fluctuation is an important low frequency excitation source of vibration and noise of ship. In addition to the propeller, structure-borne noise and airborne noise due to the main and auxiliary equipment excitation sources are also considered as the main sources of cabin noise. The emissions noise from exhaust chimney of engine room is another important noise sources which impact on the rear compartments of the superstructure. Engine room fans are the noise sources which can impact on the noise levels in their cabins.

2.2 Statistical Energy Analysis

Statistical approaches in dynamical analysis have a long history. In mechanics, we are most familiar with the application to the vibration is that its randomness in time and space domains even for a deterministic system.

A characteristic of higher order modes analysis, however, is basic uncertainty in modal parameters. The resonance frequencies and modes and shapes of these modes show great sensitivity to small details of geometry and construction. In addition, the computer programs used to evaluate the mode shapes and frequencies are known to be rather inaccurate for the higher order modes, even for rather simplified systems. For the treatment of these uncertainties, a statistical method of the modal parameters seems quite natural and appropriate. One advantage of Statistical Energy Analysis (SEA) may be seen from the practical aspects of cabin acoustics. The SEA allows for much simpler description of the system, whether one describes the field by nodes or waves. In the cabin noise analysis, modal density, average modal damping, and certain average of modal impedance to sound sources are required. In a wave description, such parameters as mean free path for waves, surface and volume absorption, and general geometric configuration are also required.

With the improvement of method，SEA has reached a very satisfactory precision for engineering applications and been the best way for solution of complex dynamic problems in higher frequency band in nowadays. As a complementary, the modal method and FEM is adapted to solve the complex dynamic problems in lower frequency band. Thus, FEM & SEA will be able to cover the entire analysis band of cabin noise problem.

As a example, they are successfully used to analyze noise problem of cabins and spaces on board ship during design phase of a new oil tanker. The SEA model for a large oil-tanker is shown in Fig2.

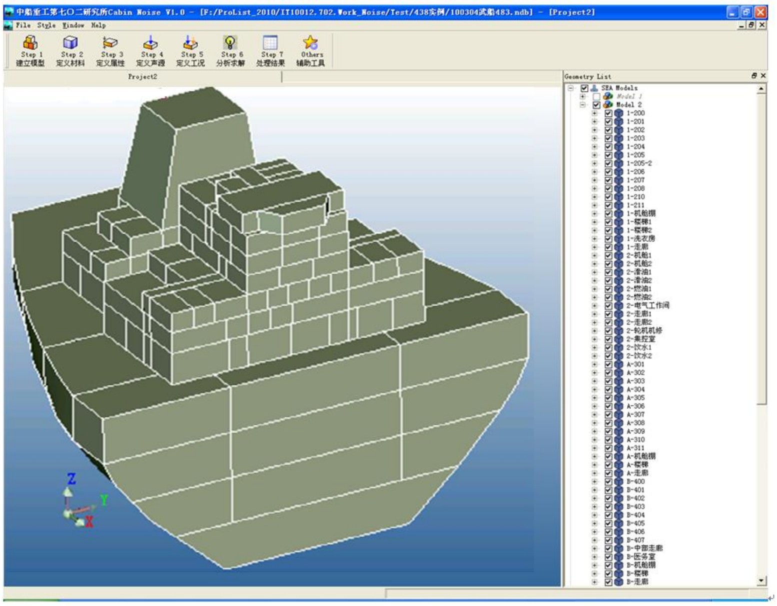

Fig2 SEA model for large oil-tanker

3. Results and control measures

After calculating, cabin noise level results are shown in Table 1. Noise level values plotted on accommodation decks are shown in Fig3 to Fig9.

Table 1 Cabin noise level results for Oil-tanker

Deck	Location	Predicted/dB(A)	Limited/dB(A)	Measured/dB(A)
Navigation Deck	wheel house	58.7	65	60
	bridge wings	72.1	70	71
E deck	captain room	46.3	60	48
	captain bed room	47.5	55	48
	chief officer room	47.8	60	47
	chief officer bed room	47.1	55	47
	2nd officer	51.9	55	/
	3rd officer	51.4	55	/
	pilot	52.1	55	/
D deck	chief engineer room	47.8	60	48
	chief engineer bed room	48.7	55	48
	2nd engineer day room	49.0	60	49
	2nd engineer bed room	48.4	55	48
	3rd engineer	52.5	55	/
	4th engineer	52.1	55	/
	spare officer	52.6	55	/
C deck	electrician	49.5	55	/
	crew (A)	53.2	55	52
	crew (B)	52.7	55	52
	cadet(A)	48.6	55	47
	cadet(B)	49.8	55	50
	cadet(C)	49.6	55	/
	cadet(D)	53.0	55	/
B deck	fitter	50.7	55	/
	chief cook	50.3	55	/
	boy	50.5	55	/
	bosum	50.0	55	/
	sailor A	50.9	55	52
	sailor B	50.4	55	50
	sailor C	49.9	55	50
	sailor D	49.7	55	51
	sailor E	54.2	55	/
	sailor F	53.3	55	/
	sailor G	53.1	55	/
	motorman A	49.5	55	/
	motorman B	49.6	55	/
	motorman C	49.8	55	/
	motorman D	50.4	55	/

Deck	Location	Predicted/dB(A)	Limited/dB(A)	Measured/dB(A)
	motorman E	54.5	55	/
	motorman F	53.4	55	/
	motorman G	53.2	55	/
	pump man	50.0	55	/
A deck	galley	67.8	75	/
	cargo control room	54.2	60	/
	ship's office	52.3	60	51
	captain's office	52.8	60	52
	crew's mess room	54.3	60	/
	crew's recreation room	55.2	60	/
	officer's mess room	55.0	60	55
	officer's recreation room	53.6	60	55
	conference room	53.9	60	/
	c/engineer's office	52.5	60	/
Upper deck	work's room (6P)	57.6	55	53
	work's room (4P)	57.1	55	53
	hospital	56.8	55	52
	treatment room	56.2	55	52
	gymnasium	56.6	60	/

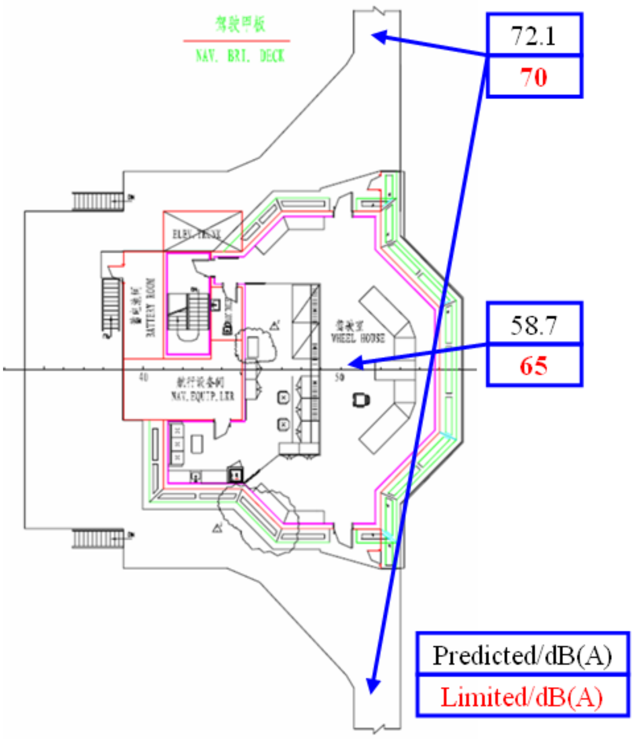

Fig3 Noise level values plotted on Navigation deck

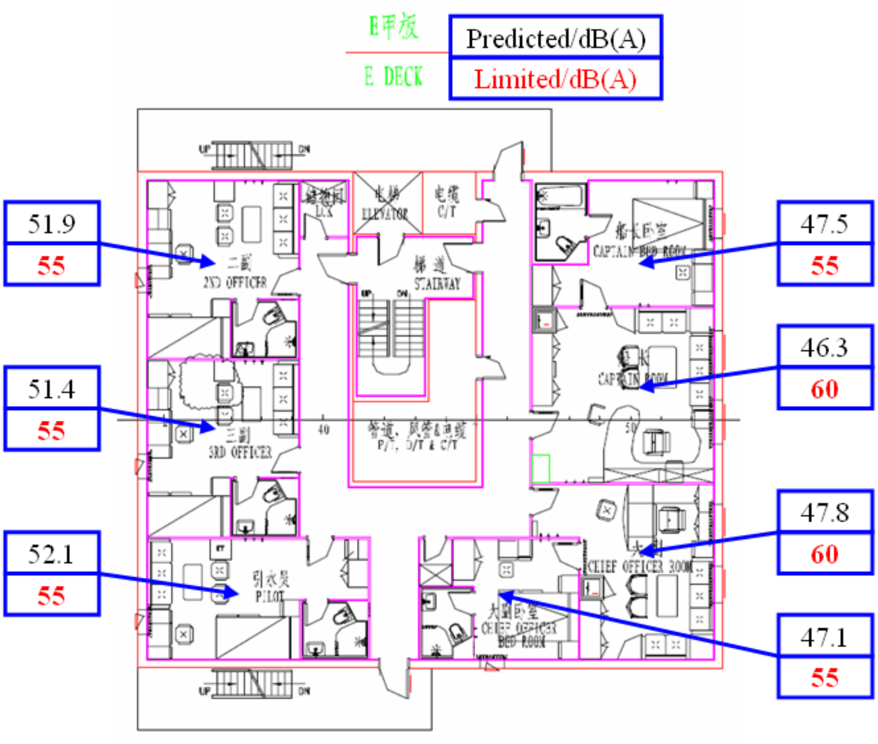

Fig4 Noise level values plotted on E deck

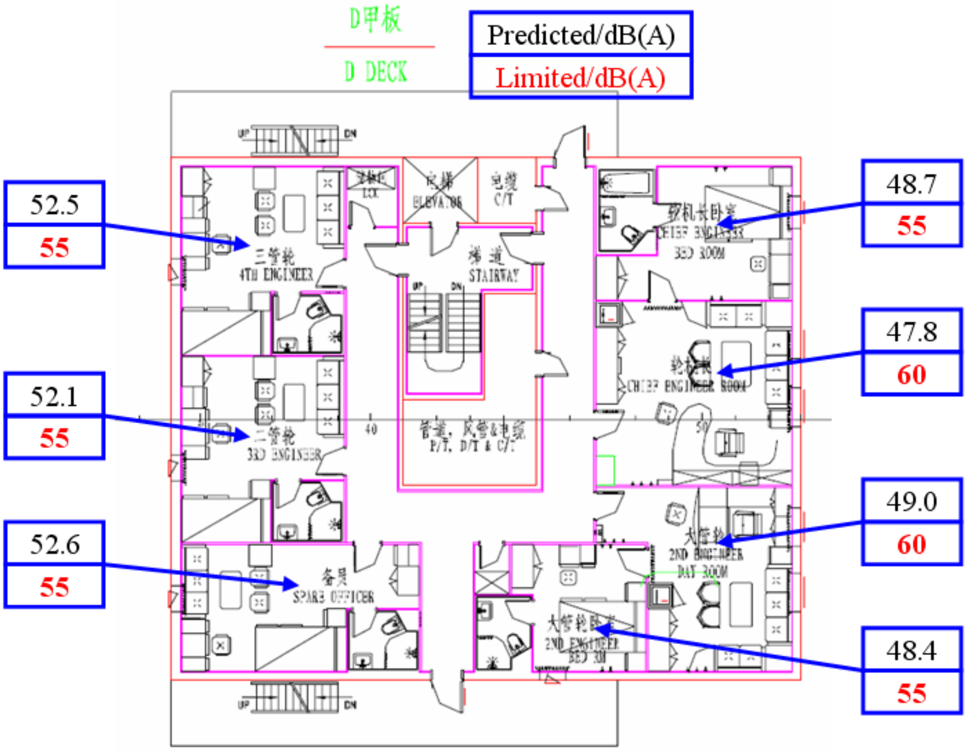

Fig5 Noise level values plotted on D deck

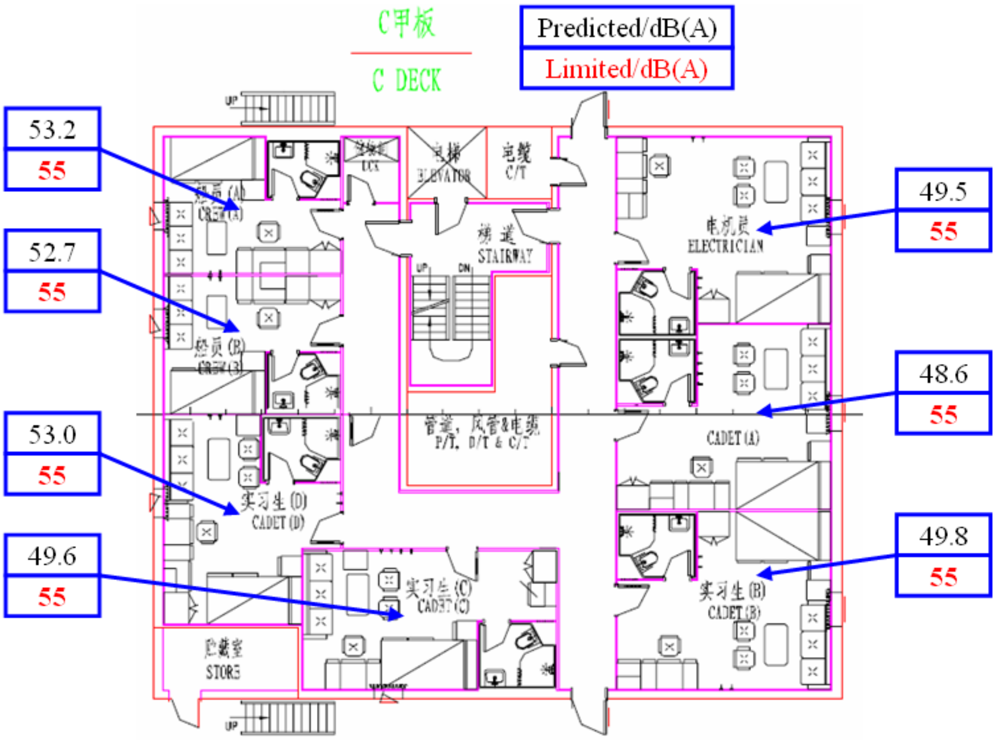

Fig6 Noise level values plotted on C deck

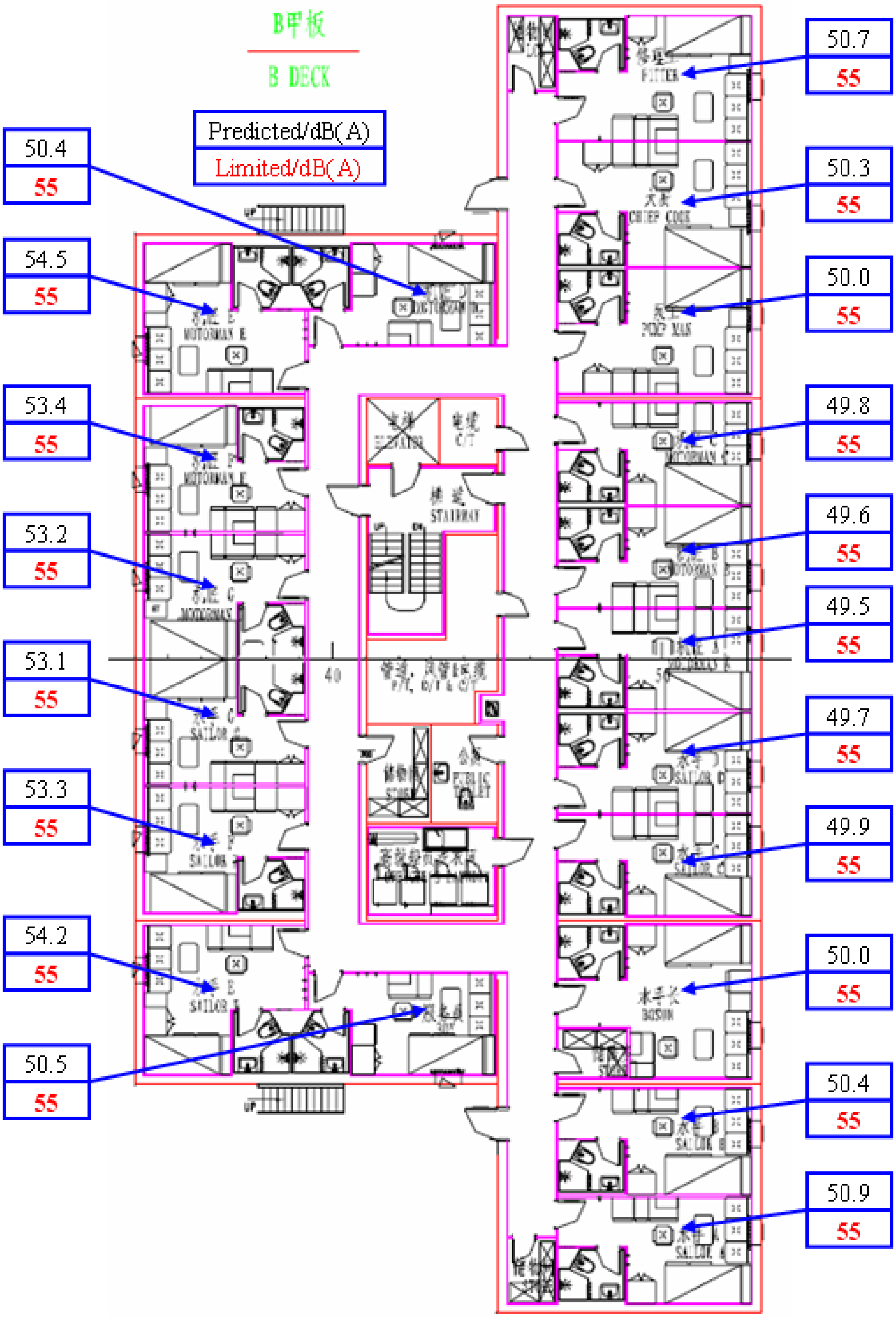

Fig7 Noise level values plotted on B deck

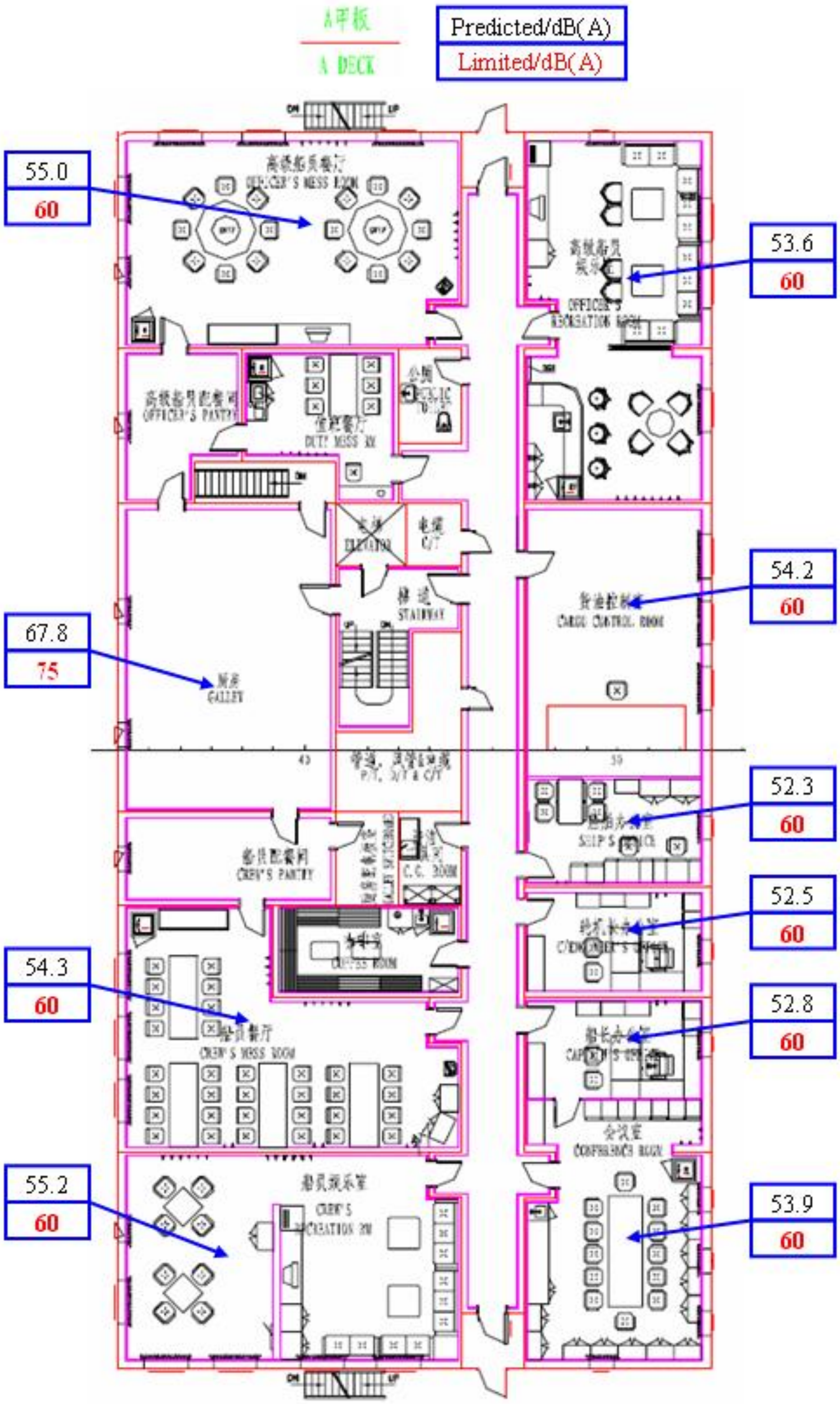

Fig8 Noise level values plotted on A deck

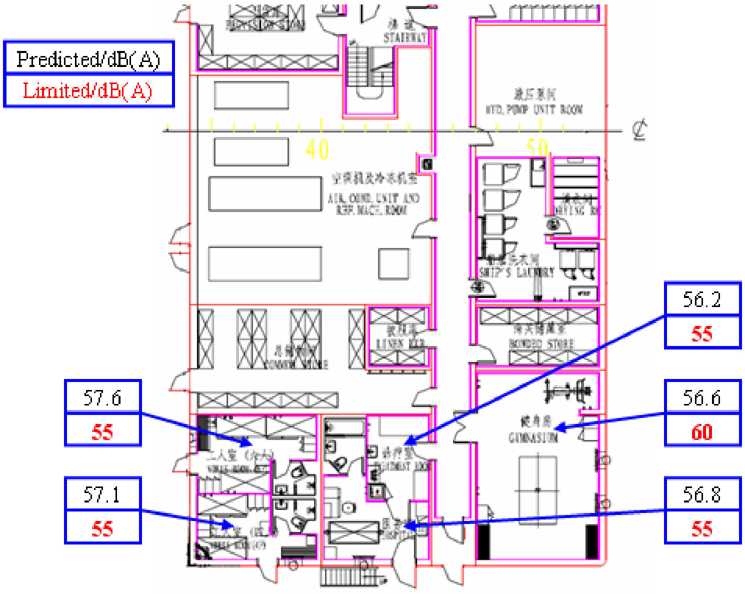

Fig9 Noise level values plotted on Upper deck

It is found that the noise level of accommodation spaces on the main deck exceed the limit of 55dB (A).And the noise levels on two wings of the navigation room also can not meet the limit requirements in the guidelines.

Therefore, two recommendations of noise control measures have been proposed in the improvement design:

Floating Floors are used in all of the accommodation rooms on the main deck (used). The internal structure of the exhaust stacks of engine chamber can be designed to sound absorption channel with micro-perforated plate (not used).

After improved design, the noise levels in various spaces and cabins are able to meet the limit requirements of guidelines.

Table 2 Cabin noise levels after control measures

Deck	Location	Initial/dB(A)	Ultimate/Measured	Limited/dB(A)
Navigation deck	bridge wings	72.1	66.4/71	70
Upper deck	work’s room (6P)	57.6	54.3/53	55
	work’s room (4P)	57.1	53.9/53	55
	hospital	56.8	53.4/52	55
	treatment room	56.2	52.8/52	55

4. Conclusion

The acoustic prediction results were consistent with cabin noise levels of the real ship test.

The acoustic prediction helps to early detect excessive noise spaces and guide to make noise control measures during the design of the oil-tanker.

Accommodation spaces as much as possible not to be arranged on the main deck, or floating floor should be laying in these cabins.
The intake and exhaust stacks should be as far away as possible from the accommodation spaces, otherwise, intake and exhaust air noise will impact on the noise levels in these areas.