中国船舶工业行业协会

The 6th Asian Shipbuilding Experts' Forum, Guangzhou

The design technique of cabin noise control on the merchant ships

China Ship Science Research Center

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1 Outline

The pollution and harm of the ship cabin noise to human and the environment have already attracted attention of international community and related organizations.

Auditory of human

1 Outline

The draft Code on noise levels on board ships—approved by MSC 90

	A468	DE53/10	DE56	
			1.600-10.000 GT	≥10.000 GT
Work spaces:				
Machinery spaces	110	105	110	110
Machinery control rooms	75	70	75	75
Workshops	85	80	85	85
Non–specified work spaces	90	85	85	85
Navigation spaces :				
Navigating bridge and chartrooms	65	65	65	65
Listening posts	70	70	70	70
Radio rooms	60	65	60	60
Radar room	65	65	65	65
Accommodation spaces :				
Cabin and hospitals	60	55/60	60	55
Mess rooms	65	60	65	60
Recreation rooms	65	65	65	60
Open recreation areas	75	70	75	75
Offices	65	65	65	60
Service spaces:				
Galleys, without food processing equipment operating	75	70	75	75
Serveries and pantries	75	———	75	75
Normally unoccupied spaces:				
Spaces not specified	90	———	90	90

1 Outline

Additionally, industry partners' attention should be paid to the IACS submission MSC 91/3/14 to MSC 91 meeting next week, a dozen of comments/problems proposed/identified by IACS were also identified in our practice.

Some examples:

1 Outline

1) "Noise measurements shall be taken at normal service speed and no less than 80% of the maximum continuous rating (MCR)."

“Since normal continuous rating of ice-class ships is normally 50 to 60% of MCR, it may be impractical to carry out at not less than 80 percent of MCR for all ship types. In current practice, noise measurements are conducted at normal service speed. Therefore, IACS proposes that the wording "and no less than 80% of the maximum continuous rating (MCR)" should be deleted. ”

1 Outline

2) "Measurements as specified in 3.4.2, 3.4.3 and 3.4.4 shall be taken with the ship in port condition."

"It is noted that the provisions set out in paragraph 1.3.4 of the Code specify the types of vessels to which the Code will not apply. However, for the vessel types not specified in paragraph 1.3.4 there are a number of "in port conditions" that could be applicable e.g. when discharging/loading cargo. Therefore, IACS is of the opinion that a definition of "in port condition" will need to be developed."

1 Outline

3) "When measuring noise levels at the intake and exhaust of engines and near ventilation, air-conditioning and cooler systems, the microphone should, where possible, be placed outside the gas stream at a distance of 1 m …

"IACS believes the purpose of paragraph.3.10.3 is unclear, because no other provision requires this measurement on the intake and exhaust openings of relevant installation/engine (rooms/cabins) in the draft Code. "

1 Outline

4) "On open deck, measurements shall be taken in any areas provided for the purpose of recreation and additionally where a preliminary investigation indicates that the limits specified in 5.3.5 may be exceeded."

“ It is understood that section 4.2.3 of the Code should apply with respect to the measurements for open deck spaces for recreation purposes. However, the latter part of 3.13.4, i.e. "additionally where a preliminary investigation indicates that the limits specified in 5.3.5 may be exceeded" causes confusion in whether the provisions of paragraph 5.3.5 should also apply. IACS seeks clarification relating to these issues.”

1 Outline

- Implementation of the Code should not cause a lot of chaos and disputes among shipyards/ shipowners/class societies.
- IACS' submission is timely and major ambiguities / impracticality in the draft Code shall be addressed/cleared up before IMO finally adopts the Code

1 Outline

There should be an striking billboard “Get into strong noise area, ear protection needed.” out of cabin stronger than 85dB(A).

caution card

flexible ear plug

The mechanism study and control of cabin noise also get the concern of more and more scholars.

2. Control methods & prediction techniques

2.1 General control methods

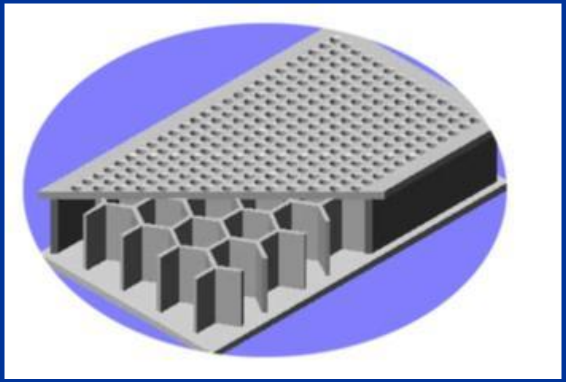
2.2 Prediction techniques

2.1 General control methods

1） **sound-absorbing material**

2） **acoustic shield**

3） **packing block**



2.1 General control methods

1） sound-absorbing material

Add the sound-absorbing material into the space that the reverberation time is long and the reflect is strong can get the best effect.

We suppose sound absorption coefficient at the medium frequency is about 0.2,if lay sound-absorbing material on the hull body of the machine and the cabin, making the sound absorption coefficient increase to 0.4, we can get

$$10\lg\frac{a_2}{a_1}=10\lg\frac{0.4}{0.2}=3\ \text{dB}$$

This reduction has smaller effect to the reverberation field ,but it to human's subject feeling has a good effect.

2.1 General control methods

1） sound-absorbing material

Because the piping and other accessory connect to the bulkhead and the ceiling ,it is difficult to lay sound-absorbing material large acreage in the cabin.

Actually, it is not necessary to lay sound-absorbing material in every part and corner, mostly chose the surface around strong sound source.

General speaking, sound-absorbing material has more effect to high-frequency noise , so use the sound-absorbing material in the machine with high speed is more effective.

2.1 General control methods

2） acoustic shield

The noise from the machine include the structure noise and the air noise.

Make the machine closed in a steel encloser can let the air noise down.

Besides necessary air inlet and outlet, the encloser must air-tight.

2.1 General control methods

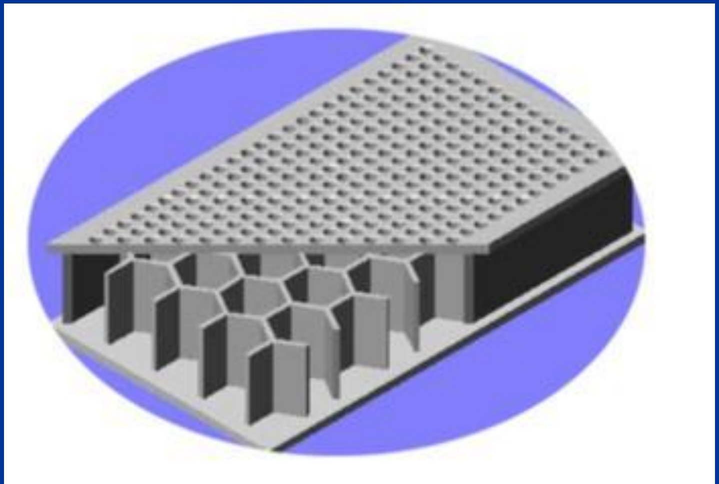
2） acoustic shield

In order to make the noise lowest, laying sound-absorbing material in the inner of the enclosers. Dissipative muffler should be fixed in the air inlet and outlet .In order to avoid the structure noise, machine and the enclosers should have elastic base.

2.1 General control methods

3） packing block

The board, decker and bulkhead connect to the hull can radiation noise to the cabin . In order to low down this noise ,packing block can lay on the structure surface.



2.1 General control methods

3） packing block

Mass of the buoyant raft floor should be as heavy as possible. The floor should not connect to the hull directly.

In order to control the vibration of packing block, Inner wall and ceiling should connect with the elastic hull structure.

2.2 Prediction technique

Prediction technique is the core of cabin noise control.

frequency → low frequency → couple of structure and fluid

frequency → medium-high frequency → statistic energy method

couple of structure and fluid → hydrodynamics of ships

couple of structure and fluid → structure dynamics of ships

2.2 Prediction technique

Finite element method to structure

Dynamics equation

Natural mode

Potential flow theory

Wet surface

General hydrodynamic force

Exciting

Couple equation

Response of principal coordinate

Prediction of response of structure、wave load …

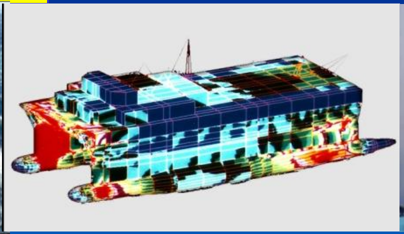
Three dimensional hydroelastic method is applied.

Dry modal mass、damping、stiffness matrix

$$=\ [a+A]\{\ddot{q}\}+[b+B]\{\dot{q}\}+[c+C]\{q\}=\{\Xi\}$$

General hydrodynamic coefficient

General exciting



2.2 Prediction technique

We obtain the cabin noise:

$$L_A = 10\log_{10}\left[\frac{\sum_{j=1}^{N_D}\left(p_j^2\right)}{p_0^2}\right]$$

where p_j **is the sound pressure level (dB(A));**

N_D **is the number of wave band.**

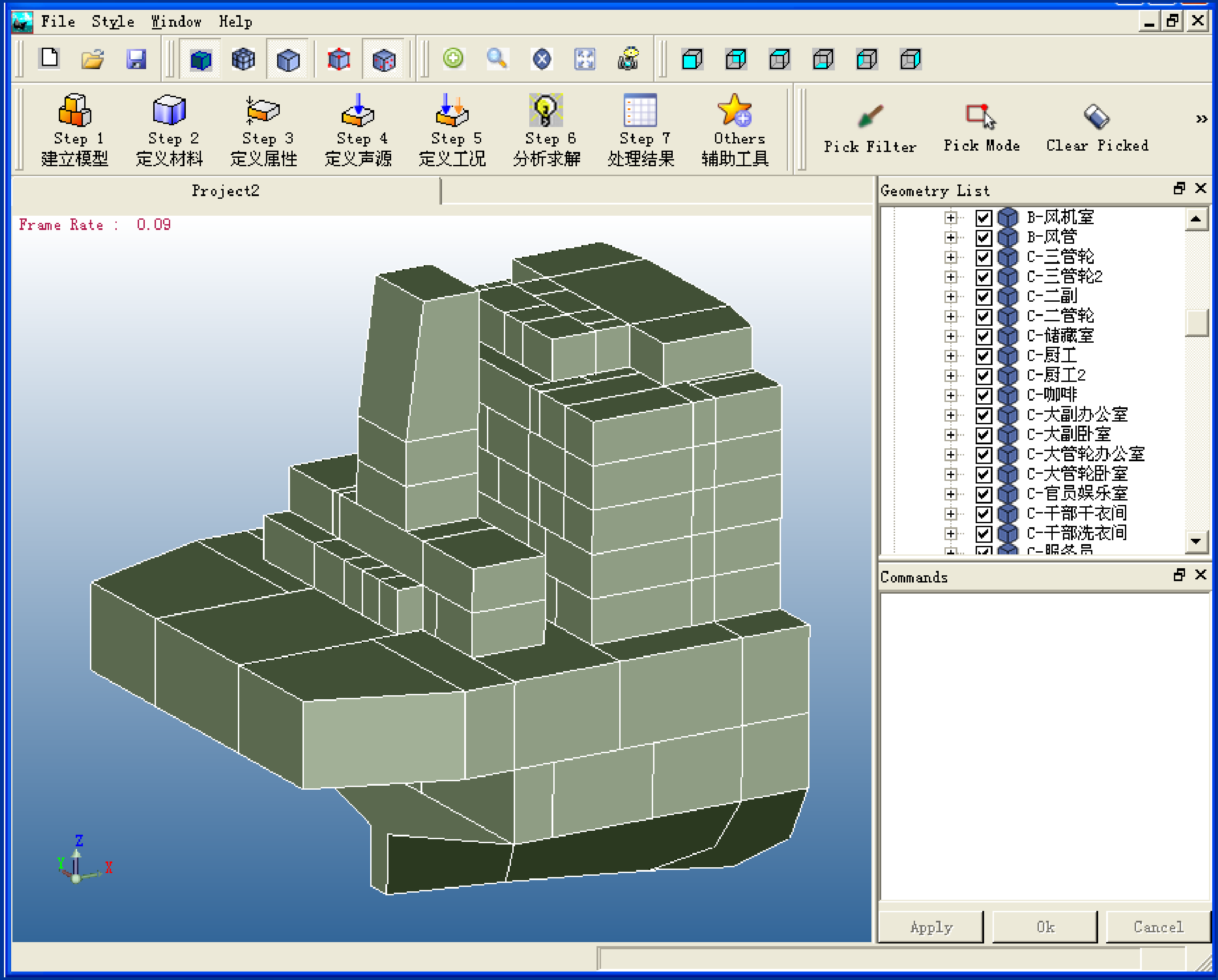
2.2 Prediction technique

An example：

80,000t Panama cargo ship.

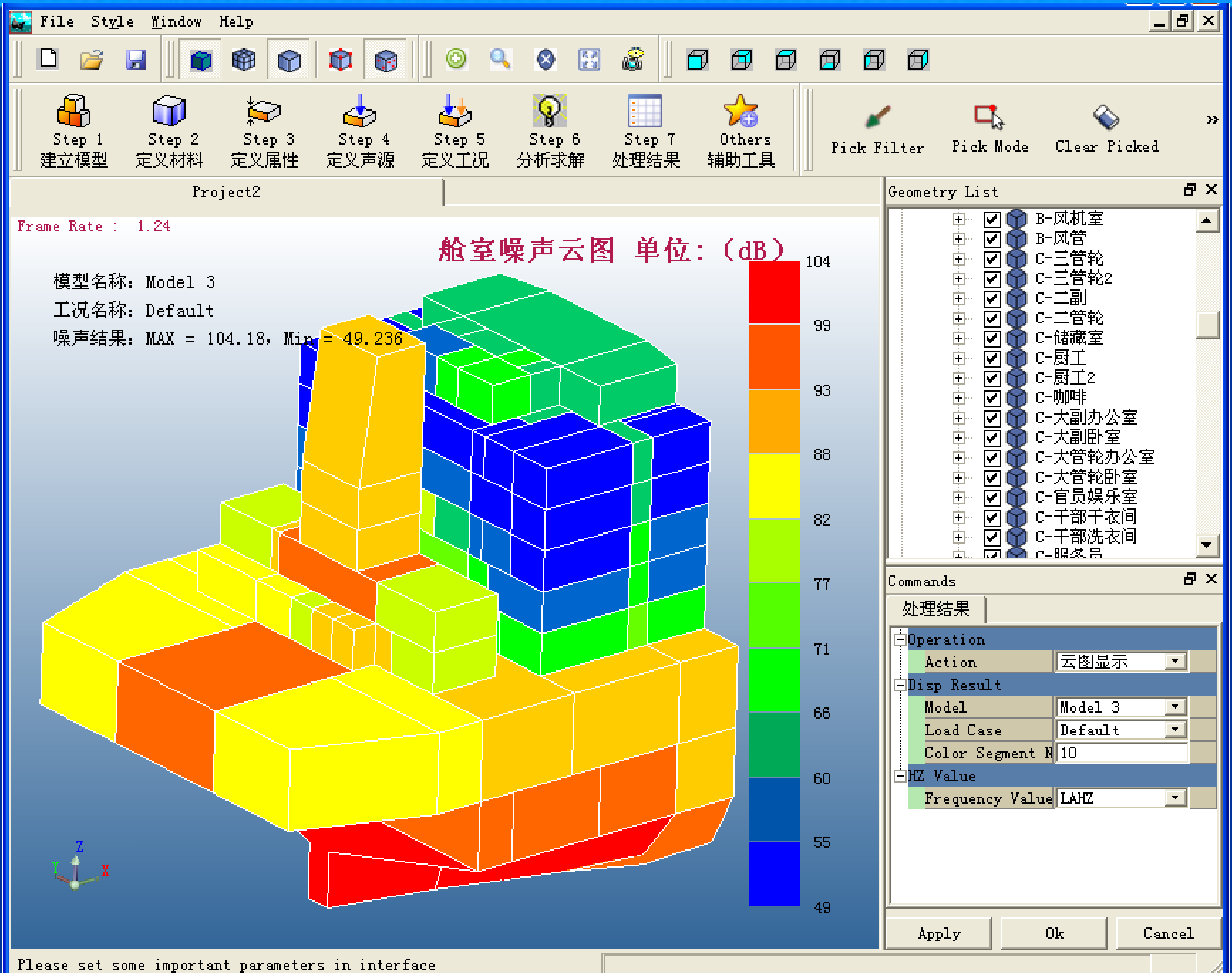
960 subsystems including 790 plate elements and 170 sound field elements from -5＃～38＃ rib.

2.2 Prediction technique



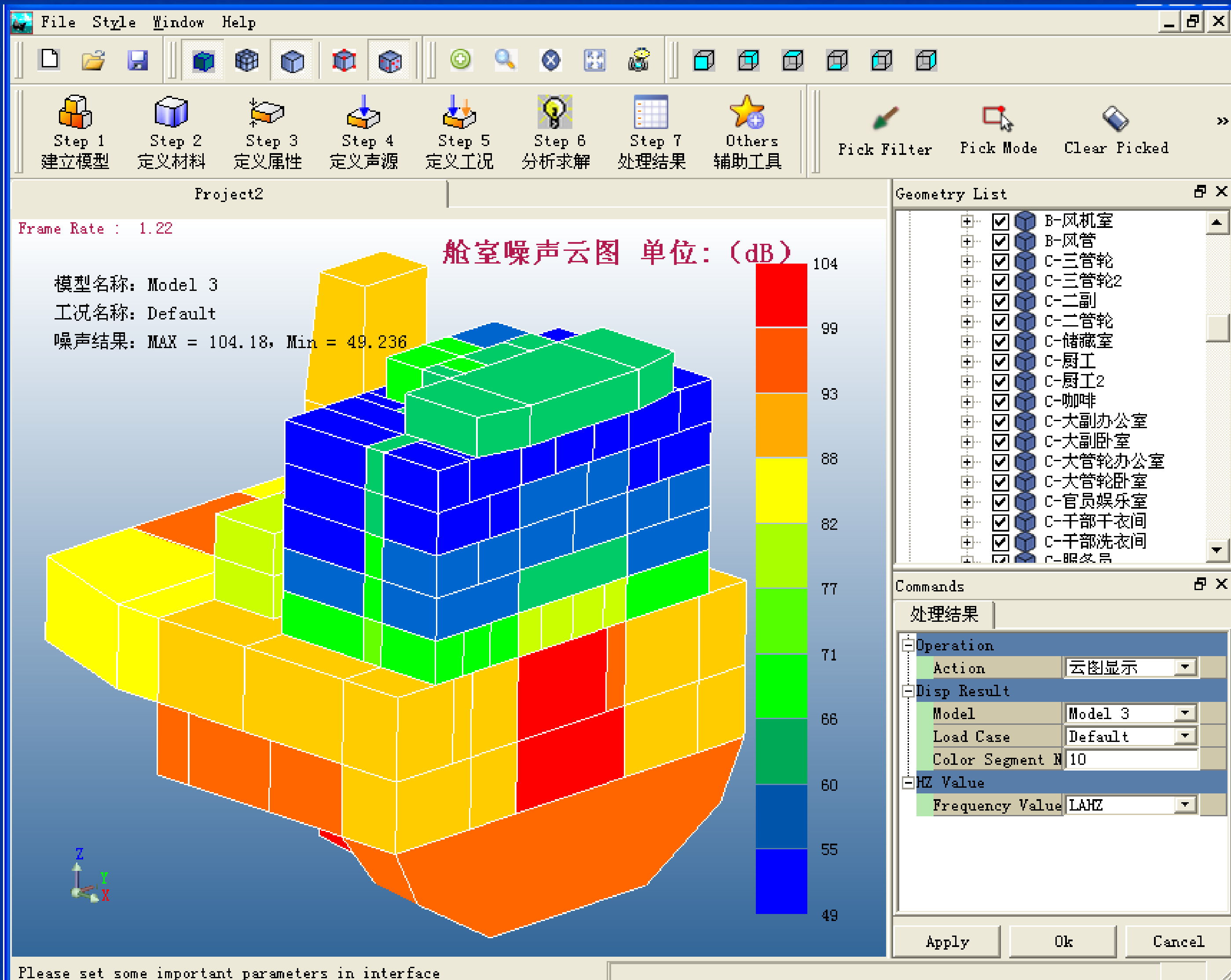
Model

2.2 Prediction technique



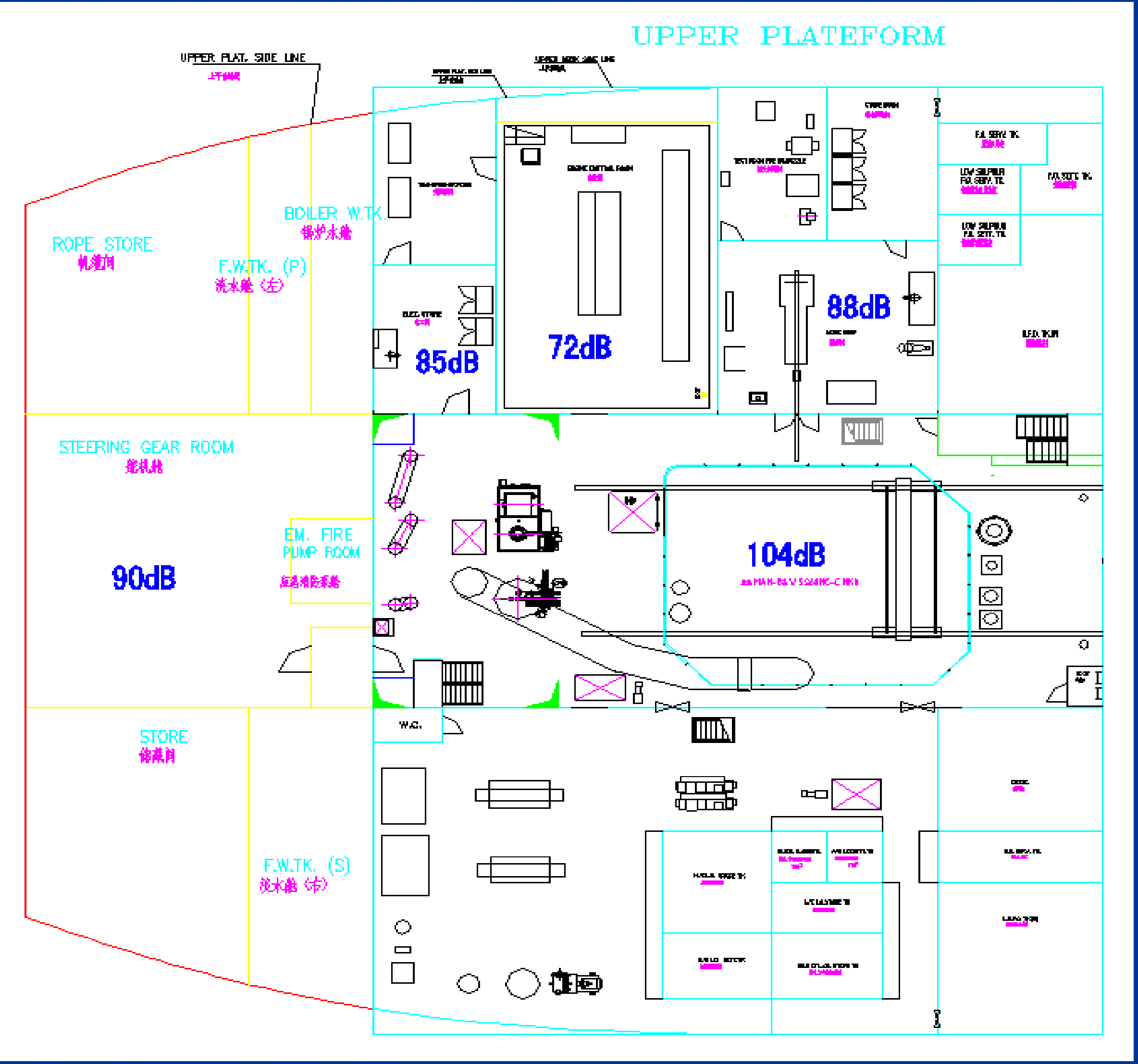
nephogram of cabin noise

2.2 Prediction technique



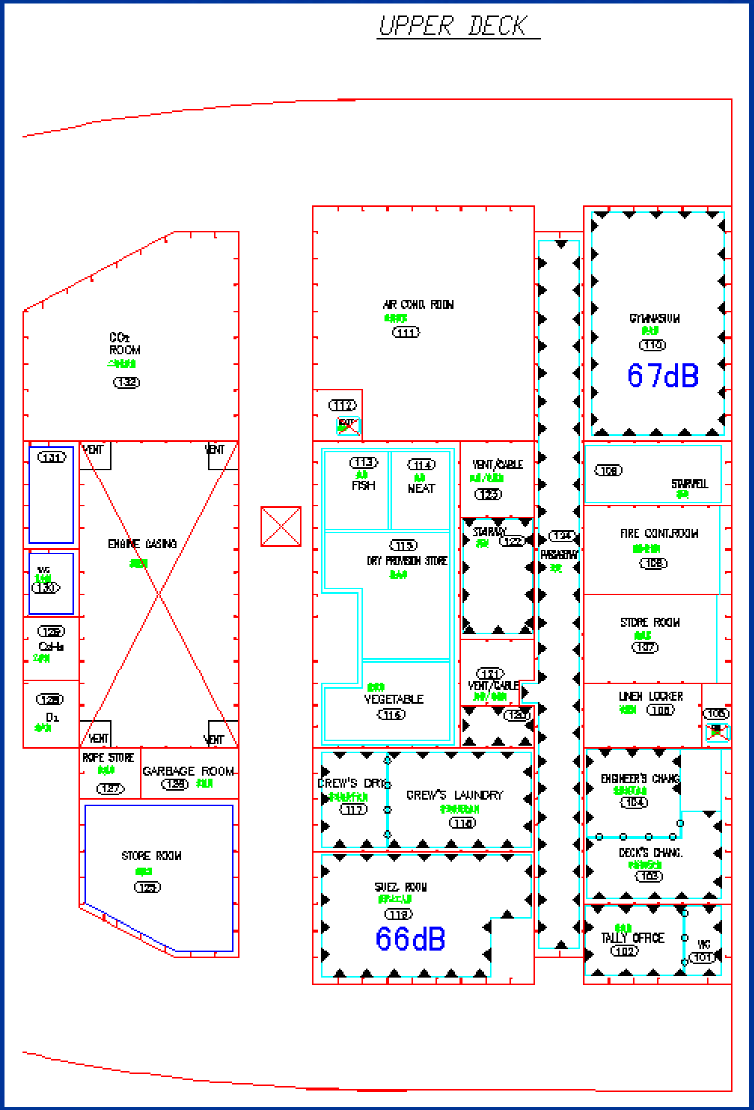
different view

2.2 Prediction technique



nephogram of upper platform

2.2 Prediction technique



nephogram of upper deck

2.2 Prediction technique

80,000t Panama cargo ship.

Two cabins exceeding noise limits were identified with measures introduced at the design stage. Quite satisfactory results at new building stage.

Thank you for your attention！