Research on Design, Construction and Maintenance Technology of Advanced Marine Research Ship

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Abstract. In response to my country’s future planning for the design and construction of a new round of marine scientific research ships, the types, functions and layout areas of special equipment are subdivided to classify and explore the key points of special equipment installation and control for marine scientific research ships, and finally become more systematic. Formed the installation control elements of various special equipment. Combining previous production design and construction experience of scientific research ships, the article focuses on the scientific layout of survey equipment, optimized design of cabin clear height, reasonable layout of laboratory equipment and related pipelines, vibration and noise reduction, electromagnetic compatibility, and modular design. On the other hand, analyse the key points of the comprehensive layout optimization design of the scientific research ship for reference for subsequent production design of the scientific research ship. Together with the experience and concepts of the shipyard, the comprehensive layout of the scientific research ship can be further improved, and the on-site construction modification can be reduced, thereby promoting domestic the construction quality of scientific research ships has improved to a new level, reaching the international leading level in all aspects.

Keywords: Marine scientific research ship, ship design, maintenance, construction, layout.

1. Introduction

A strong understanding of marine scientific exploration is a solid foundation for building a maritime power. Among them, the marine scientific research ship is the most basic tool and carrier for exploring the ocean. The marine scientific research ship is a platform that carries marine scientists to the scene and applies special equipment, lifting equipment, working decks, research laboratories and other special equipment required to perform the missions to directly observe the ocean, collect samples and research the ocean. A powerful guarantee tool for naval combat capabilities [1]. A strong understanding of marine science exploration is a solid foundation for building a maritime power. Among them, the marine scientific research ship is the most basic tool and carrier for exploring the ocean. The marine scientific research ship is a platform that carries marine scientists to the scene and applies special equipment, lifting equipment, working decks, research laboratories and other special equipment required to perform
the missions to directly observe the ocean, collect samples and research the ocean. A powerful guarantee tool for naval combat capabilities. By reviewing the development history of marine integrated survey ships, according to the needs of modern deep-sea marine scientific research, focusing on the realization of functions of ship-borne survey equipment, this paper analyses the requirements of the use environment of the equipment, and proposes the layout and optimization of the laboratory and its system. Proposal.

2. Composition and function of modern comprehensive scientific research ship investigation equipment
As shown in Figure 1, the modern marine comprehensive scientific research ship survey equipment mainly includes two parts, namely the operation control support system and the scientific survey equipment.

![Figure 1. The composition of a typical comprehensive scientific research ship survey equipment](image)

2.1. The composition and function of the control support system
The control support system refers to the equipment that supports and assists the use of various investigative equipment and jointly completes scientific research operations. Including winch system, hoisting and retracting system, gas explosion air compressor, ship network system, etc. Among them, the gas explosion air compressor refers to the equipment that provides compressed air for multi-channel seismic systems, and the ship network refers to the system that realizes the functions of survey data management, ship management, portal website, and survey management [2].

2.1.1. The winch system. The winch system generally includes a thermoset depth profiler (CTD) hydrological winch (CTD winch for short), optical cable winch, coaxial cable winch, geo-fibre cable winch, steel cable winch, etc. Its functions are shown in Table 1.
Table 1. Functions of the winch system

| Winch name          | Features                                      |
|---------------------|-----------------------------------------------|
| CTD winch           | Put in temperature and deep salt profiler and water extraction |
| Optical cable winch | Used for visual equipment such as visual grabs, optical trailers, and deep-sea drilling rigs |
| Coaxial cable winch | Used for visual grab, deep towing, etc.       |
| Fibber cable winch  | Heavy geological sampling, such as column sampler, large box sampler, etc. |
| Steel cable winch   | Used for biological trawl, geological trawl, etc. |

2.1.2. Lifting and retracting system. Lifting and retracting systems generally include rear stern A frame, sideboard A frame, telescopic boom crane, CTD telescopic crane, column sampler auxiliary retracting equipment, etc. Its functions are shown in Table 2 on the following page.

Table 2. Functions of Lifting and retracting System

| Winch name                          | Features                                                                 |
|-------------------------------------|--------------------------------------------------------------------------|
| Rear A Frame                        | Devices that support the delivery from the end                           |
| Side A Frame                        | Hanging CTD on the sideboard, or column sampler, box sampler             |
| Telescopic crane                    | Used for inboard movement of equipment, deck hoisting equipment, buoys, submersible targets, capsule gun arrays, etc. |
| CTD telescopic crane                | CTD operation for buried cabin design                                   |
| Columnar sampler auxiliary retractable | Used for retracting and releasing long cylindrical samplers (greater than 12m) |

2.2. Composition and function of scientific investigation equipment

2.2.1. Oceanographic survey ship. According to different classification methods, marine survey ships have different systems. This article is classified according to the survey tasks, including comprehensive survey ships, professional survey ships and special marine surveys. The comprehensive survey ship is mainly engaged in the comprehensive survey of marine basic scientific experiments; the professional survey ship has a smaller hull than the comprehensive survey ship, and has a single task, such as marine hydrological survey ships, marine geological survey ships, etc.; special survey ships refer to structures built for special tasks Special survey ships, such as ocean-going survey ships for aerospace, polar survey ships, deep-sea drilling ships, etc.

2.2.2. Manned submersible. Manned submersibles (HOV) mainly include scientific research, deep-sea exploration, sightseeing and military applications from the perspective of usage. Operational manned submersibles used for marine scientific research can be divided into shallow water operation type manned submersibles (operating water depth less than 1000m), deep water operation type manned submersibles (operating water depth less than 1000m) and Full-sea deep operation manned submersible (maximum working depth exceeds 10,000 meters), etc.

2.2.3. Unmanned submersible. Unmanned submersibles mainly include cable remotely controlled submersibles (ROV), autonomous unmanned submersibles (AUV), underwater gliders (AUG) and remotely controlled/autonomous composite submersibles (ARV). According to the operating capacity, ROV can be divided into 300-meter light/medium/heavy load type, 1000-meter light/medium/heavy load type, 3000-meter light/medium/heavy load type and 6000-meter light/medium/heavy load type. According to the operating water depth, AUVs can be divided into shallow sea AUVs, deep sea AUVs, and 10,000-meter-level AUVs; underwater gliders are new unmanned submersibles based on the development of AUVs. The remote control/autonomous composite submersibles combine the sufficient
power of ROV and AUV the advantages of freedom of movement and unrestricted operation, their operating water depth also spans from shallow sea to full sea depth [3].

2.2.4. Deep sea space station. The deep-sea space station has a diving depth of hundreds to several kilometres, and can autonomously navigate long distances or stay on the seabed. It carries several deep-sea detection devices, ROV, AUV and underwater cranes and other operating equipment, which can be divided into dozens of tons according to its normal displacement. Mini deep-sea space station, 100-ton small deep-sea space station, 1,000-ton medium deep-sea space station, etc.

3. Functional positioning and design and construction

3.1. Scheme configuration

3.1.1. Selection of ship type scheme. Due to the small number of professional pipeline survey ships worldwide, there are not many ship types available for reference. But its function is equivalent to that of a small survey ship or research ship, so refer to a similar survey ship or research ship. In view of the functional positioning and use requirements of the ship, and referring to the existing foreign 2 advanced survey ships and offshore support ships, two construction plans are proposed. The ship type adopts steel, partial double bottom, continuous deck, and fully electric welded structure, and is equipped with a dedicated stern A frame, folding boom crane, professional winch, and electric propulsion ship type, but the 2 plans have the main scale The difference is that under the premise that the length and displacement of the ship are basically the same, there are certain differences in the width and draft of the ship, so there are certain differences in the stability and seakeeping of the two options. The main scales determined by preliminary analysis and calculation are shown in Table 3.

| Main scale                  | plan 1 | plan 2 |
|-----------------------------|--------|--------|
| Length between perpendiculars Lbp/m | 58.8   | 58.8   |
| Width B/m                   | 13.0   | 11.8   |
| Type depth D/m              | 8.0    | 8.5    |
| Design draft Td/m           | 4.8    | 5.3    |

Option 1 has a wider ship width, smaller draft, better stability, can complete operations in higher sea conditions, can better meet its emergency oil spill investigation work under severe weather, and achieve better economic benefits and social benefits. Option 2 has a smaller ship width, a larger draft, a relatively long rolling period, better seakeeping, and a certain improvement in crew comfort, but the stability is poor, and the stability reserve for emergency operations in high sea conditions is small. After comprehensive comparative analysis, the recommended scheme 1 is the preferred scheme [4].

3.1.2. Electric drive equipment selection. Electric propulsion usually refers to a propulsion system that uses an electric motor to drive the ship's spiral award. The electric motor is supplied by a generator, and the generator is supplied by other sources of power. It is a way to not only provide power for electric drive propulsion, but also provide power for the ship's daily electricity system. A complete electric propulsion system can be divided into five parts: power generation module, power distribution module, propulsion module, thruster module, and management module, as shown in Figure 2. Each module contains the corresponding key equipment.
Figure 2. Basic composition of ship electric propulsion system

The power generation module is mainly composed of a prime mover and a generator. The main function is to generate electrical energy for all electrical loads on the ship. Among them, the prime mover can be a diesel engine, a gas turbine, etc. The power distribution module is mainly composed of a marine switchboard, a large-capacity air circuit breaker, and a comprehensive protection device, and is mainly responsible for the unified distribution of electrical energy throughout the ship. The propulsion module is mainly composed of a marine rectifier transformer, a marine propulsion frequency converter, and a marine propulsion motor, which mainly realizes the speed adjustment of the propeller.

3.1.3. Research crane equipment. During the loading process of the scientific research crane, the completeness and accuracy of the installation interface data such as the levelness of the lower end of the crane cylinder, the flatness of the hull base, and the marking of the crane flange surface must be checked first; the data calibration is completed, often The crane is divided into two steps: crane tower hoisting and jib hoisting. During this period, there are main operations such as tube butt, welding, cable threading, oil injection, and limit positioning. Finally, check the installation integrity of the crane and measure the amount of bearing sinking. A representative installation process is shown in Figure 3.
3.2. Main functions

This ship is a modern submarine pipeline route survey ship. According to the different purposes of the pipeline survey and survey, the pipeline survey and survey are divided into 3 working stages. At the same time, due to the different pipeline conditions (burying, exposed) and working areas (shallow water, deep water) involved, the content of each stage is different. Phase I: Pipeline survey, using traditional shipborne pipeline instrument to cross the predetermined route of the pipeline according to the minimum distance required by the operation manual with the S-shaped survey line, and determine the accurate passing point of the pipeline according to the data of the pipeline instrument; for the exposed seabed in deep water area For the pipeline, the side scan sonar (with a magnetometer) is used to fly along one side of the pipeline to obtain the detailed route of the pipeline. Phase II: Detailed investigation of the pipeline [5]. After obtaining the route of the pipeline, operate the high-resolution shipborne shallow formation profiler and the multi-beam echo sounder to obtain the fine line of the pipeline and the environmental status of the pipeline, and use the shipboard ADCP to collect the route along the pipeline the flow rate and flow direction information. Pipeline inspection: Operate the ROV to perform a detailed, image-level state inspection of the exposed pipeline. If there is a leak alarm, use the oil and gas monitoring sensor mounted on the ROV to locate the leak point.

4. Maintenance technical analysis

4.1. Improve the quality of scientific research ships

Improving the quality of scientific research ships can effectively improve their ability to resist risks and reduce the occurrence of shipping accidents. The crew should have a full understanding of the hull, clarify the vulnerable parts of the hull structure, organize professionals to regularly evaluate the equipment status, and establish technical files. Regularly evaluate the technical status of the old research ship, and re-assess the purpose of the research ship based on the evaluation results, and scrap the research ship with poor technical status and no repair value [6].

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**Figure 3.** Installation flow chart of the crane
4.2. Strengthen maintenance
The voyage should conduct routine inspections of scientific research ships, and deal with problems in time if problems are found, especially for old scientific research ships to conduct comprehensive and detailed inspections to avoid potential safety hazards during the voyage. After use, it is necessary to strengthen the daily maintenance, maintenance and maintenance of the scientific research vessel, so that the old instruments and equipment can be replaced in time to ensure the normal use of the equipment. At the same time, the maintenance and replacement records should be kept to facilitate the overall maintenance of the scientific research vessel and troubleshooting. During the voyage, it is necessary to constantly check the operation of various instruments and equipment to ensure normal operation, and timely report and handle the malfunctioning equipment.

5. Conclusion
As an important platform for ocean exploration and research, marine scientific research ships are a key component of ocean capacity building and an important manifestation of a country's comprehensive national strength. In response to my country's new round of technical requirements for the design and construction of marine scientific research ships, this paper will classify and explore the key points of special equipment installation and control of marine scientific research ships by subdividing the types, functions and layout areas of special equipment, and finally form various scientific research ships. The installation control elements of the test equipment. In the follow-up, we will continue to strengthen the long-term accumulation and supplementation of special equipment loading elements for marine scientific research vessels, expand technical depth, consolidate technical strength, ensure the engineering quality of the subsequent construction of my country's marine scientific research vessels, and promote my country's oceanographic research and research. Develop faster.

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