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Design of Cargo Hold Ventilation Electrical System for PCTC

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ABSTRACT

The design of the PCTC cargo compartment ventilation system is an important system in the overall PCTC ship design, which is related to the design of multiple specialties such as general, structure, outfitting, machinery and electrical section. In recent years, the design of the cargo hold ventilation system for PCTC ships has also been constantly changing, improving, and optimizing. This article summarizes and optimizes the current mainstream design schemes for the electrical system of PCTC cargo hold ventilation, taking into account both the construction cost of the shipyard and the operating cost of the shipowner, for reference by relevant designers.

KEYWORDS

PCTC; Cargo Hold Ventilation; Electric Control.

1. INTRODUCTION

In recent years, with the rapid development of the global automotive industry, the demand for car roll on/roll off ships has also increased significantly. Pure Car and Truck Carrier (PCTC) is a new type of ship that can transport land transportation vehicles such as small cars, trucks, dump trucks, forklifts, etc. It has the characteristics of high technical requirements, fast speed, multiple deck layers, large vehicle loading capacity, high cargo value, and complex cargo hold ventilation system.

In a closed PCTC cargo hold, vehicles generate exhaust gases during boarding and disembarking, causing harmful gases such as carbon monoxide (CO) to be present in the air. Even when the vehicle is stationary, the fuel system of the vehicle may emit flammable gases [1]. To ensure the health of personnel in the cargo hold, the cargo hold ventilation system needs to inject fresh external air to maintain the air quality inside the cargo hold. Due to the large cargo hold capacity, the ventilation system is extensive and equipped with numerous fans. The design of the cargo hold ventilation system has become a key focus of this type of ship design.

2. VENTILATION DESIGN FOR CARGO HOLD

2.1. Design Requirements for Cargo Hold Ventilation

Total cargo holds ventilating system are divided into 5 separate group A/B/C/D/E, detail of control function for each group is normally as follows, Shut-off damper of each fan and shut-off louvers of each natural vent should sent open/close status to asscociated cargo hold fans control system [2].

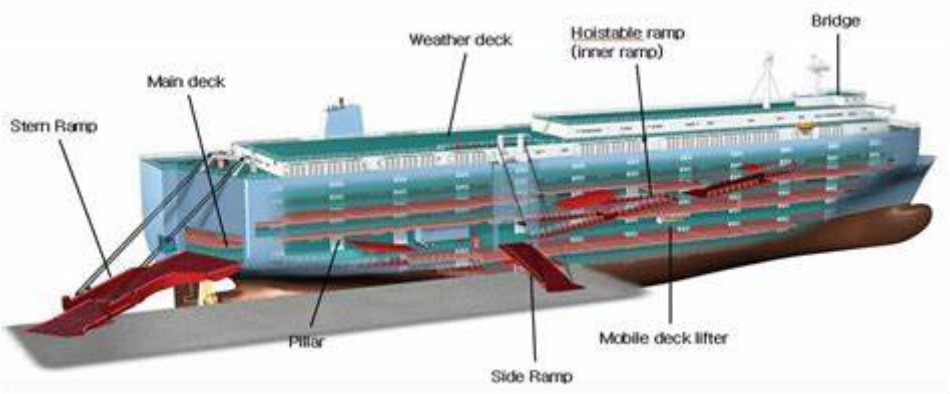

Fig 1. Typical arrangement of PCTC

2.1.1. Operating Mode Choices

Loading/unloading mode & Sailing mode for each group cargo hold can be operated in Local/Remote or Group/Individual

2.1.2. Local/Remote Choice

Each group cargo hold ventilation fans can be controlled both local or remote. When local is selected, the fans can be controlled in the local control panel (in fan control room). When Remote is selected, the fan scan be controlled from bridge console and cargo control room, touch screen shall be supplied (has the same function as the local control panel).

2.1.3. Group/Individual Mode Choice

Each group cargo hold ventilation fans can be start/stop individually or in group through the change-over Group/individual on the panel That means when "Group" selected, the fans can be controlled in group in sequence (fan to be started one by one in group, automatically, with interval time around 2-3 sec, the delay time can be also set by user).

When "Individual" selected, the fan can be controlled one by one individually, When a fan is started, the related dampers will automatically start firstly 2-3 sec before fan starts.

2.2. Electrical Interlocking with External Systems

All fans' running status is associated with dampers, ramp positions, stern door/side door positions, main lightings, CO_2 system, fire alarm system and so on.

2.2.1. Shut-off Damper / Shut-off Louver

Each fan's damper and each cargo natural trunks' shut-off louvers are interlocking with related fans. it is sure that in any case, when shut-off the damper / louver, its related fans have to be stopped automatically; and if damper/louver is closed, its fans cannot be started. After damper/louver is opened, the related fans can be started.

2.2.2. Ramp, Stern/Side Door Position

At "Loading / Unloading" mode, interlock between all each space fans starting and the related ramp, stern/side door. if fans are stopped, their related ramp, stern/side door cannot be started.

2.2.3. CO_2 System

When the system receives a CO2 release signal, all fans should be stopped.

To ensure the safety of personnel and equipment, the system is designed to automatically shut down all ventilation equipment upon detection of a CO2 leak. This immediate response is critical in

preventing the spread of the gas and minimizing the risk of asphyxiation or other hazards associated with high levels of carbon dioxide.

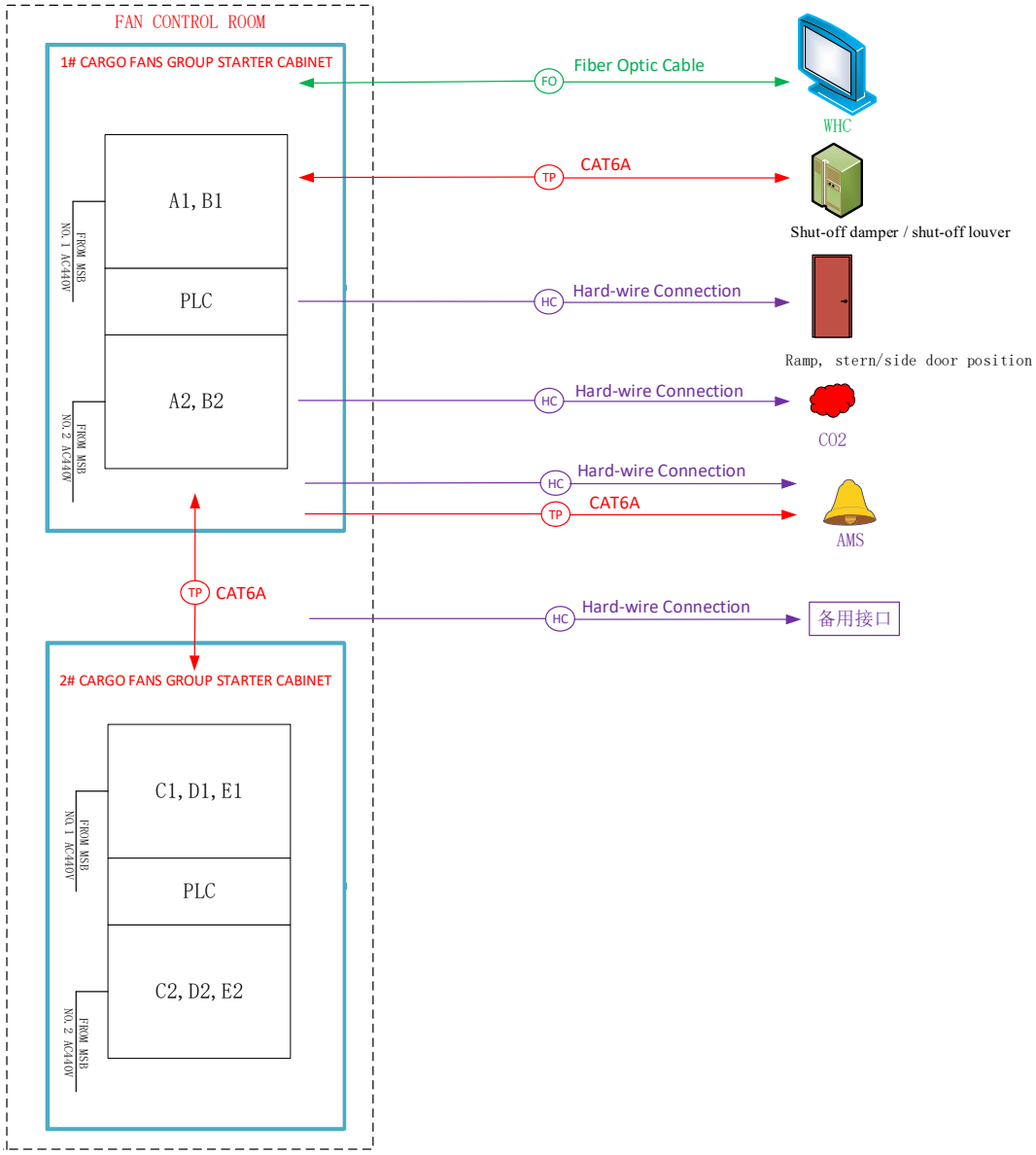

Fig 2. Electrical interlocking with external systems

2.2.4. Fire Alarm System

When receiving signals from the fire alarm system, the fan should be stopped, to ensure the safety of the vessel, the system is equipped with an automatic shutdown function that immediately stops the operation of the fan upon detecting a fire alarm signal. This measure can prevent the spread of smoke and toxic gases, which is crucial for the safety protection of crew and ships.

2.2.5. Main Lighting

When the cargo hold fan adopts a mechanical air supply form, it can avoid the explosion-proof lamp from sending a no potential signal to the main lighting system, reducing the production cost of the shipyard. If the cargo hold fan fails and cannot meet the requirements of ventilation frequency or air volume in the cargo hold, according to the classification society regulations, the entire cargo hold area belongs to a dangerous area, and non explosion-proof lamps cannot meet the usage requirements. Therefore, when the fan fails, it is necessary to stop the use of normal lighting lamps, that is, to cut off the normal lighting power supply of the relevant cargo hold area[3].

2.3. Maintenance Stop/Start Switches

One local maintenance stop/start switch for each fan house unit should be pre-installed nearby each cargo hold fan for maintenance purpose.

2.4. Design of Distribution Cabinet

Due to the large number of cargo hold fans, all electrical cargo hold ventilation equipment should be installed in two control panels, which should be equipped with a base. Control panel 1 is used for spaces A and B, while control panel 2 is used for spaces C, D, and E.

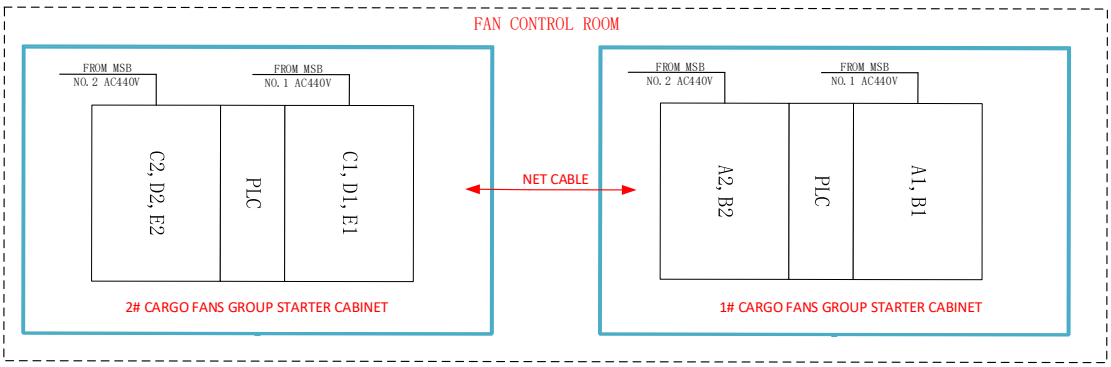

Fig 3. Design of distribution cabinet

Which has following function on each:

1. Start/stop for all deck fans

2. Group start/strop for fans by each cargo hold (Each group starter board shall be fed from the NO.1 MSB feeder and NO.2 MSB feeder)

3. Control all cargo hold fans according to Cargo group, complete with RoRo Ventilation modes choice (Loading/unloading mode & sailing mode), Local/Remote choice, Group/Individual mode choice

4. Touch screen for monitoring related equipment and control of fans. When touch screen is out of work, manual switch shall be provided to control fans.

5. All shut-off dampers / shut-off louvers monitoring

6. Necessary interlocks

7. Hardwire connection to emergency stop system

8. Spare RS485 modbus to AMS (common alarming and signal)

3. CONCLUSION

The cargo hold ventilation system is one of the key systems of automotive roll on/roll off ships. Its design requires selecting appropriate ventilation methods based on the specific situation of the actual ship, planning smooth flow field distribution, arranging air ducts reasonably and optimizing resistance, effectively controlling noise, and achieving convenient operation through flexible and variable control systems. In the design process, it is not only necessary to ensure the effective operation of the ventilation system under various working conditions, but also to take into account the construction cost of the shipyard and the operating cost of the shipowner, and maintain good coordination and communication with various specialties including overall, structural, and electrical.

So for car roll on/roll off ships, it is necessary to carefully consider the overall plan of the cargo hold ventilation system during the research and development quotation stage, and continuously optimize it during the detailed design process.

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