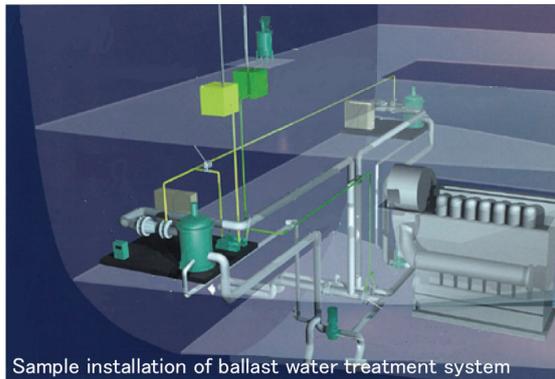


## Our Efforts to Reduce the Work Period for Installing Ballast Water Treatment Systems



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*The compulsory installation of ballast water treatment systems on oceangoing ships has recently been introduced in order to protect the ecosystem of marine life. Upon installing the treatment system according to this new rule, in terms of existing ships currently in service, it is desirable to minimize the influence of the installation on normal operations. The installation of this system, in which a great deal of steel engineering, plumbing and wiring is required, is hard to complete within the period when a ship is docked for a regular checkup. However, by utilizing various measurements and computer-aided design (CAD), and by implementing advanced preparation and preliminary work, the installation was completed within the desired work period without interference with the ship's normal operations.*

### 1. Introduction

The installation of this system requires a great deal of steel engineering, plumbing and wiring. However, it is difficult to secure sufficient time for the installation work if the ship is in service. Therefore, the work needs to be completed in a short time according to the ship's operational schedule.

Currently, there are various kinds of ballast water treatment systems available, the selection of which is at the discretion of the client. Consequently, the ship builder in charge of the installation work is required to arrange specific equipment and plumbing suitable for the system selected by the client. However, the existing equipment, a detailed layout plan of the plumbing and working drawings of the ship on which the installation work will be conducted, which are necessary for preparation and planning, are often unavailable.

In this kind of remodeling and installation work, it is extremely difficult to perform an appropriate design process for each system beforehand without the detailed drawings. Furthermore, the installation work cannot be completed in the time period requested by the client if the ship builder starts the preliminary study and the actual construction after the ship is brought into the shipyard.

Accordingly, Mitsubishi Heavy Industries, Ltd. (MHI) participated in an installation project requested by a client from the initial deliberation stage in order to conduct engineering work including designs based on various measurements. Furthermore, interference with the ship's normal operations due to the installation work was kept to the minimum, and the work was completed in a shorter time by arranging work plans in accordance with the ship's operational schedule.

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## 2. Outline of installation of ballast water treatment system

There is concern that the discharge of ballast water transported by oceangoing ships will adversely affect the ecosystems of marine life. In order to prevent an increase in such impacts on the ecosystem, the compulsory installation of a system that appropriately processes ballast water (hereinafter referred to as a ballast water treatment system) is being introduced as an international rule. Currently, there is a wide range of ballast water treatment systems available, each of which has specific properties and adopts various different treatment methods. Therefore, the size of the main unit of individual systems, their number and of course the specifications of the accompanying accessories greatly differ from one another. Consequently, there are no common standards for the installation work applicable to every system. Naturally, an appropriate method for connecting to and combining with the existing plumbing also needs to be individually planned and tailored to each system.

On the other hand, ships currently in service were not originally designed in consideration for the installation of such a treatment system at a later date. Optimal locations in which the various pieces of equipment of the system are to be placed, or spaces in which plumbing can be newly installed, are not always sufficiently available. In terms of the ship structure, even in sister ships with basic specifications and designs that are identical, some modifications are usually added to the newer model. Therefore, two identical ships never exist.

The installation work needs to deal with different treatment systems and ships, as well as to arrange the most suitable design and work plans according to the specific system selected by the client. In addition, to take the ship's operational schedule into account, the work has to be completed keeping the impact on the ship's operations to a minimum.

## 3. Important factors and efforts in reducing the work period

The following four major factors must be observed in order to shorten the work period. Let's take close look at these factors individually and determine the best way to complete the installation work without interfering with the ship's normal operations.

### 3.1 Planning and design process

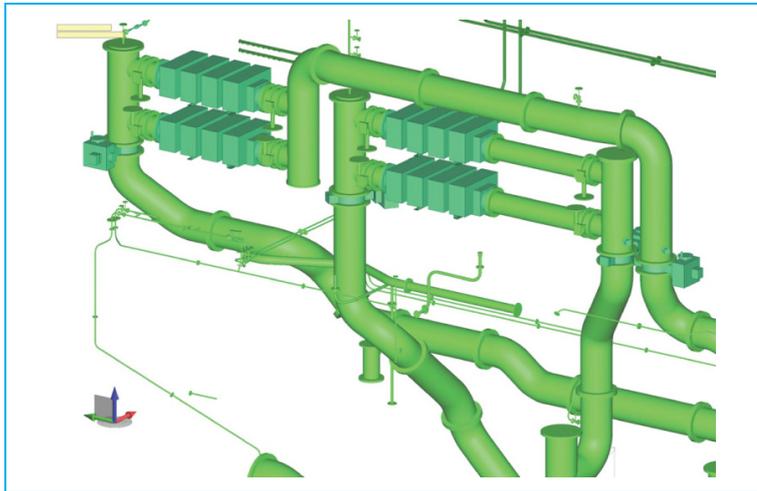
The planning and design process consists of two major stages.

The first stage is the basic design in which the system's overall specifications and the plumbing layout are first determined. The basic design includes (1) the client's requests, (2) the current state of the ship on which the new system is to be installed, such as the particulars of the existing related equipment, and (3) the specifications of the new system to be installed. These three elements need to be comprehensively analyzed in order to finalize the specifications in order to achieve a feasible plan. This process can be done solely by the client or a design firm separately appointed by the client. However, if the ship builder in charge of the actual installation work is allowed to participate in the project from the initial stage, and their opinions and suggestions are taken into account, the installation work will be undertaken smoothly and will be completed in a shorter period of time.

The second stage is the detailed design stage in which drawings for the actual work are prepared. In the case of large-scale installation work such as this system, the quality of the working drawings greatly affects the entire installation project, since the need for adjustments and corrections required on site mostly depends on the accuracy of the working drawings. Therefore, in order to prepare accurate working drawings, it is very important to closely understand the current state of the ship interior, including how the existing plumbing and equipment are placed.

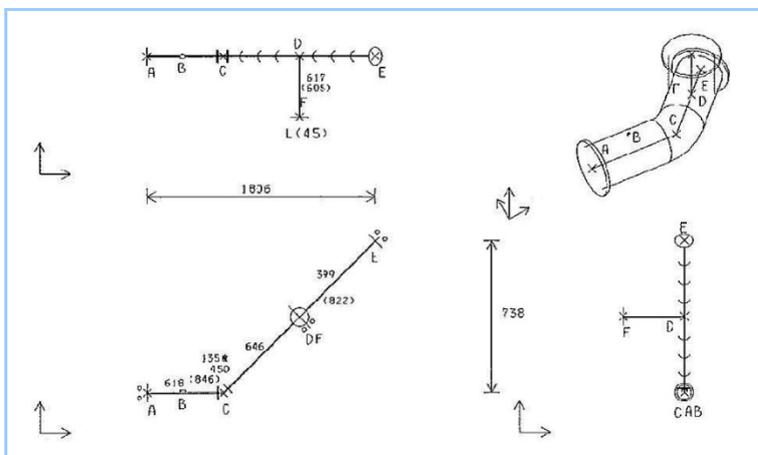
To proceed with these two design stages is relatively easy if the working drawings prepared at the time when the ship was newly built are still available. However, in many cases, the drawings with the necessary information are unavailable. In this case, high quality working drawings can be made by measurements using a 3D scanner and a method of preparing the drawings using 3D CAD (three-dimensional CAD). Consequently, the actual installation work proceeds smoothly, allowing a reduced work period. (**Figure 1** and **2**)

The planning and design process usually takes approximately 6 months.



**Figure 1 Design using 3D CAD**

Installation of equipment and design of newly added plumbing were performed using 3D CAD after executing 3D scanning.



**Figure 2 Pipe drawing for fabricating based on 3D CAD**

Pipe drawings are output using 3D CAD in order to prepare plumbing in advance.

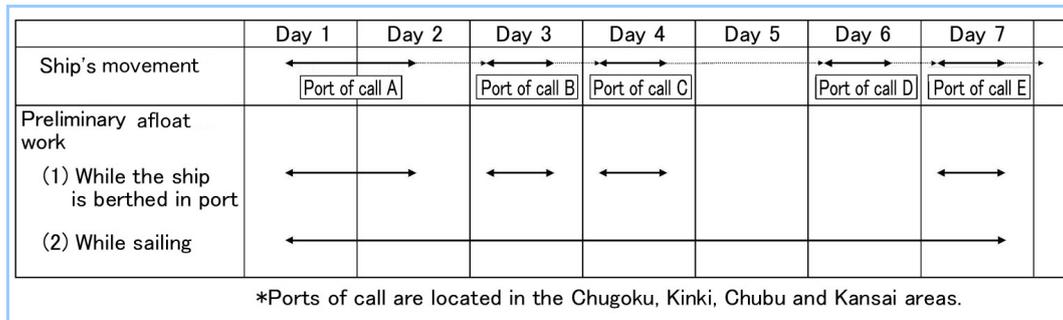
### 3.2 Preliminary operations

In ordinary repair work, in the case of a small-scale remodeling, measurements may be taken on site, and a cradle and plumbing may be prepared while the ship is docked. However, large-scale remodeling like this installation work in which a great deal of plumbing needs to be prepared would take longer to complete if the measurements and preparation are undertaken only after the ship is docked. In order to reduce the work period, it is necessary to prepare appropriate plumbing and a cradle support for the system to be installed in before the actual installation work begins.

High quality and accurate plumbing arranged in this preliminary operation stage will help the installation work go smoothly afterward. Therefore, the quality of the working drawings described above and the accuracy of engineering are extremely important.

### 3.3 Preliminary on-ship engineering work

When attempting to reduce the time period for dockside engineering, the amount of work which can be done during the target period is obviously limited. In order to compensate for the lack of time, some engineering work is carried out before the ship is docked. This preliminary engineering work includes the following two types: Those in which engineers go to a port of call and do the work while the ship is berthed in accordance with the ship's operational schedule, and those in which engineers work on board while the ship is sailing from one port to the next. Ship operational schedules are usually very likely to change due to various external factors including bad weather and cargo handling. By carefully updating the information relating to the ship's operational schedule and changing engineering schedules accordingly, the preliminary engineering work was sufficiently performed. (Figure 3)



**Figure 3 Sample preliminary afloat work in running**

Engineers went to a port of call or went aboard while the ship was sailing, in order to perform the preliminary afloat work, in accordance with the ship's operational schedule.

### 3.4 Dockside engineering work

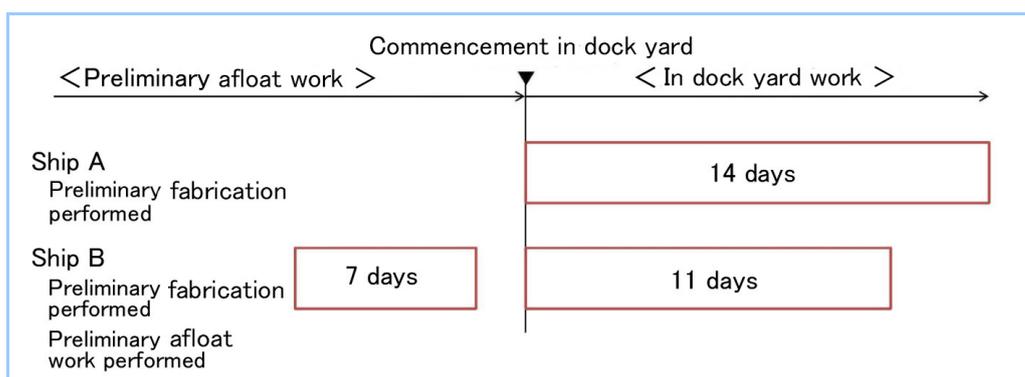
After the preliminary on-ship engineering work described above, the ship in which the new system to be installed is put into dock in order to undertake the main installation work. Apart from the installation work, test runs of the new system and usual maintenance are also performed at this time. Therefore, in order to complete all the required work procedures requested by the client while the ship is docked, it is necessary to arrange processes and time schedules for the installation work, test runs and maintenance work.

## 4. Results achieved

Examples in which MHI participated in an installation project from the basic design stage are described below.

Our achievements in performing the installation work on two car carriers of the same model are as follows. (**Figure 4**)

In Ship A, all the work procedures were performed while docked after the preliminary operations. In Ship B, in addition to the preliminary operations, the preliminary on-ship engineering work was also performed before the ship came into dock. In the preliminary engineering work in Ship B, engineers boarded the ship at a port of call in accordance with the ship's operational schedule, performed part of the work on board to the extent that did not interfere with normal operations. By determining the appropriate workload of the entire installation work, and performing the preliminary engineering work in a planned manner, the period in which the ship was out of service was reduced by 3 days.



**Figure 4 Reducing the work period in dock yard by performing the preliminary afloat work**

A comparison of the work period between 2 ships of the same model having the same system installed. The preliminary afloat work shown in Figure 3 allowed the work period in dock yard in Ship B to be reduced by 3 days.

## 5. Comprehensive analysis and selection of optimal methods

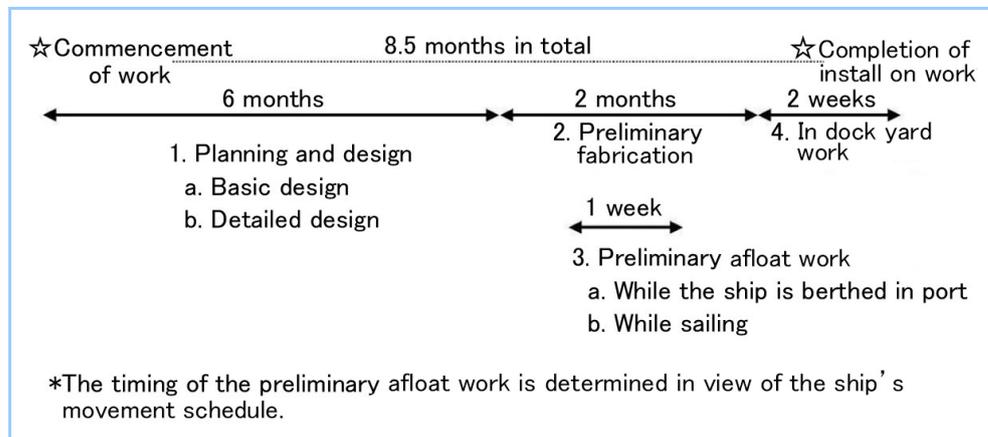
In view of the results achieved, and in order to complete the installation work in a short time, MHI acknowledged the following points as important elements in reducing the work period.

- (1) Participation in the project from the very first stage in which the system to be installed is selected, and the preparation of high quality drawings based on various measurements

- (2) The preparation of accurately designed equipment required for engineering work in the preliminary operation stage
- (3) Performing preliminary on-ship engineering work when possible during normal operations
- (4) Arranging schedules of work processes performed while the ship is docked, including usual maintenance

As long as the above points are covered, the client's needs are satisfied all along the entire work process, from the optimal model selection to the final installation stage, in a short time.

(Figure 5)



**Figure 5 A model schedule for the installation of a ballast water treatment system, from the planning and design stage to installation work in dock yard**

A time model for individual elements from the beginning of the planning and design stage to the installation work in dock yard

## 6. Conclusion

In large-scale remodeling and conversion work performed while docked, by arranging detailed planning and design, as well as allocating individual processes properly in multiple stages, the installation work can be completed minimizing the period in which the ship is out of service. In addition to the many remodeling/conversion and on-ship engineering work projects MHI has conducted in the past, our experience in the installation of the new system allowed MHI to further accumulate expertise. We are convinced that we can meet clients' needs by arranging the entire work from the design stage to the installation stage in a comprehensive manner in various remodeling and conversion projects, as well as in the installation of ballast water treatment systems, which is expected to further increase in the future.