CASE STUDIES

PLEASURE BOATS – IMPROVED LOAD HANDLING DURING SHAFT ASSEMBLY OPERATIONS

1. Organisations involved

AZIMUT YACHTS Shipyards of Turin

2. Description of the case

2.1. Introduction

The manufacture of pleasure boats requires various operations involving manual load handling. Sometimes these operations are not carried out in an ergonomically sound way, with workers operating in environments that are poorly laid out and handling items that are of sizes, weights and shapes that make it very difficult to apply any technical solution to improve work organisation.

These operations involve a definite level of risk, associated with the manual handling of loads. In many situations it is not possible to measure and therefore assess such risk because the operations concerned are not carried out in a systematic way, except for very short work processes that in any case do not affect the actual level of risk to which workers in charge of harder work processes are exposed.

Figure 1. The hull on its cradle

Below are some definitions concerning the mechanical and structural components of the boats which will be mentioned in this report and which are shown in Figure 1:

- shafts: ground steel shafts measuring between 2680 mm and 3840 mm and weighing between 66 kg and 150 kg according to boat size;
- shaft support: bracket external to the hull, assembled below the hull itself and through which the shaft passes;
- hull: lower body of the boat;
- through hull: slot made in the hull, thus enabling communication between the interior and exterior of the craft, inside which the shaft passes through;
- shafting: connection between the engine (placed inside the hull) and the propeller by means of a steel shaft;
- cradle: metal-framed trolley on which the hull and/or the boat is placed.

In a preliminary risk assessment related to manual handling of loads, both experts in charge of risk analysis and the workers themselves believed the shaft assembly phase

Figure 2. Shaft assembly phase

was particularly critical. This phase involves mechanically connecting a steel shaft between the engine, placed inside the boat, and the propeller placed outside the craft.

The shaft assembly phase may be described as follows (Figure 2): workers lift the shaft off the storage trolley, then they move it until it is placed in line with the hull in order to position the shaft at height and insert it through the hull while holding the shaft in position until it is mechanically locked.

This operation is carried out by teams of different sizes depending on the model of boat being fitted out:

- AZ 55 model: two persons, with shaft measuring 2680 mm and weighing 66 kg;
- AZ 62 model: three persons, with shaft measuring 3685 mm and weighing 111 kg;
- AZ 68 model: five persons, with shaft measuring 3840 mm and weighing 150 kg.

During a preliminary analysis the experts tried to assess the risk associated with the manual handling of loads by applying the NIOSH (National Institute for Occupational Safety and Health) method to determine the recommended weight limit, but this was not possible because the phase involved a variety of activities, unexpected spinal column postures and overload.

The experts noted that although the phase could not be properly measured and therefore the estimated risk of the manual handling could not be calculated, the risk was nevertheless present because the following problems were identified:

- the weight lifted per subject exceeded 30 kg;
- shaft lifting operations were carried out under the hull, which meant an unnatural posture had to be adopted (spinal column bent forward);
- operations were carried out in narrow spaces because of the cradle on which the hull is placed (ergonomically unsound postures);
- an inadequate grip, given the particular shape of the shaft and the surface finish quality (hand slipping);
- shaft falling risk;
- number of workers who were involved in the working procedure;
- difficulty of finding the correct shaft angle between the engine and the through hull and from these components towards the support (three fixed components);
- replacement of the shaft whenever it was damaged by knocks resulting from slipping;

- shafting assembly times which are not standard due to difficulties that teams may encounter when inserting the shaft inside the through hull.

2.2. Aims

Designing a shafting assembly and handling system that could eliminate the risk from manual handling of loads in this work procedure.

Figure 3. The shaft holder trolley

2.3. What was done, and how?

The system devised, planned and developed to carry out the shaft assembly phases is made up of two components: a metal-framed trolley equipped with a shaft holder cradle and a winch assembled on a metal-framed structure to be hooked to the inner side of the hull.

The metal-framed shaft holder trolley (Figure 3) consists of:

- six 360-degree revolving wheels equipped with mechanical brake, while the front wheels may be directionally locked by inserting the appropriate pin;
- shaft holder cradle equipped with cylindrical balls in order to enable the shaft traversing movement without scratching the ground surface and a rubber plug placed on the bottom of the cradle in order to cushion knocks;
- handle for moving the trolley and placing it under the hull;
- hydraulic cylinder to adjust the cradle angle;
- hydraulic cylinder to adjust the cradle rear height;
- oil-pressure unit equipped with: pump lever, selector for the cradle's angle or height adjustment and pressure opening and closing valve.

The metal-framed winch consists of:

- steel cable winch;
- threaded bushing to be coupled to shaft head;
- metal-framed structure to be attached to the inner side of the hull.

When the new shafting assembly system was put into effect, the operational phase was completely changed, as can be seen from the procedure detailed as follows:

(a) lifting the shaft from the storage trolley by using a bridge crane and placing it on the 'cradle' of the new trolley;

(b) manually moving the trolley under the hull;

(c) aligning the trolley with the shafting;

(d) locking the trolley's wheels by means of mechanical catches;

(e) installing the winch inside the hull;

(f) unwinding the steel cable and coupling the bushing to the shaft head;

(g) adjusting the cradle angle by operating the oil-pressure lever mechanism;

(h) adjusting the cradle's height;

(i) checking the angle by using a laser goniometer;

(j) manually activating the winch to hoist the shaft inside the hull;

(k) mechanical locking of the shaft;

(l) removing the assembly system.

2.4. What was achieved?

The main results of the project were as follows:

- workers in charge of the shaft assembly phase no longer handle the shaft manually;
- manual lifting of the shaft beneath the hull no longer occurs, therefore workers are no longer required to bend their spinal column;
- it is no longer necessary to operate in narrow spaces;
- the risk of letting the shaft slip out of one's hands has been eliminated, since manual handling of the shaft is no longer required;
- the risk of dropping the shaft has been eliminated;
- the number of workers assigned to the process has been reduced from three to two for the AZ62 boat and from five to two for the AZ68 boat;
- the use of the system in addition to a laser goniometer allows immediate and accurate determination of the shaft angle;
- reduced wear and tear on the shaft when inserting it in the through hull;
- optimisation of time required for the assembly phase.

Problems faced

The design was not easy to develop due to the number of variables associated with the use of the handling device in question:

- weight and size variability of the shafts, depending on the type of boat;
- different heights between floor level and the hulls, also depending on the boat and the cradle;
- variation of distances between the support and the through hull;
- shaft angle adjustment;
- shaft surface finish quality (ground shaft);
- presence of two threads on the shaft, one placed at the top and one at the bottom.

2.5. Success factors

A cost-benefit analysis reveals that the economic benefits (reduction in the number of workers in charge of the assembly phase, reduction in costs for shaft replacement, etc.) proved to be greater than the investments made by the company in order to develop the new systems.

2.6. Further information

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2.7. Transferability

The methods used for the risk assessment and designing a proper aid device to eliminate the manual handling of loads may be applied to cases where similar risk situations occur.

3. References, resources:

- http://osha.europa.eu/en/publications/reports/TEWE09001ENC