Personal Safety, Related Equipment and Their Advancement for Use On Ships

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ABSTRACT

Safety is the most primary concern when working on the vessels. Be it personal safety, safety of the property or the safety of the environment, utmost care has to be taken to prevent the losses of any kind. Personal safety is of the primary importance because the damage to a person or the loss of life is what the companies are mostly concerned about.

There are certain most common incidents that may result into harming the person. They range from a minor concussion to the loss of life and damage to property and environment. They are- slips and fall, man overboard, fire, workshop injuries and getting trapped in a confined space.

Over the years, there has been a considerable development to ensure personal safety. PureTech Systems has developed a system to detect man overboard and it effectively differentiates between the normal working and an abnormal incident like man overboard or piracy. SawStop has developed a table saw blade that automatically stops itself whenever there is a human contact with the blade. The principle of work is that the human body conducts electricity and when there is a change of current of operation, the brakes are automatically applied.

Personnel Positioning System is a theoretical concept for now. It is a means to detect the position of the people working on the ships and to point out the location of an accident or any such abnormality taking place. The modulus of operandi is pointing and monitoring the different levels of loading- gradual and impact, and acting accordingly.

Even though the developments are taking place, they still are no excuse to not acting cautiously. One should always remember that safety is a trait that comes from within the person. If a person is not concerned about himself, then there is nothing in the world that can ensure his safety.

Keywords: Personal Safety, Man Overboard, SawStop, Personnel Positioning System, Gradual and Impact Loading.

2.0 INTRODUCTION TO PERSONAL SAFETY

Safety is defined as relative freedom from danger, risk, or threat of harm, injury, or loss to personnel and/or property, whether caused deliberately or by accident.

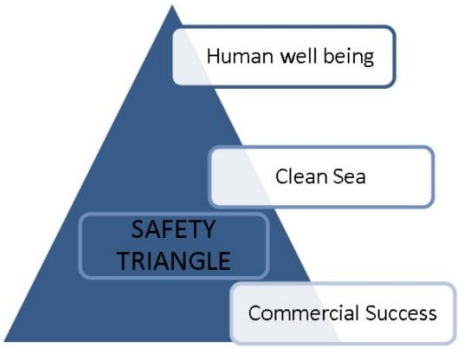

Figure 1.1 Safety Triangle

Personal safety or safety of life at sea comes at the top of priority list as there is no loss which is considered greater than the loss of human life. Shipping companies understand the importance of the safety of human life at the sea and thus rank it at the very top. It's a known fact that without an efficient crew no shipping company can survive. To ensure that all operations are carried out in an efficient and smooth manner at the sea, the shipping companies resort to "safety" as their first tool for streamlining processes. Safety in all types of operations is the key factor in ensuring that the company always maintains its position about the profit line, both efficiently and ethically.

Even when utmost care is taken to ensure personal safety, certain accidents may take place, the results of which could be catastrophic. Therefore, apart from the Personal Protective Equipment (PPE), other safety arrangements are also made available on board to prevent harm and loss of personnel and/or property.

3. ACCIDENTS THAT CAN CAUSE PERSONAL DAMAGE

There are a number of accidents that can happen while on board and some, if not all, of them can prove to be very dangerous to a person's life. Some of them are:

3.1 Slips and Falls

Slips and falls are one of the most common accidents that occur on ship's deck. Slips can easily take place at any moment and likely during an activity on deck. Falls are most common while working on heights such as on masts, lashing bridges, hatch covers, cargo holds and working aloft or outboard. It can cause severe injuries and can be fatal.

Figure 3.1.1 Working at heights

3.2 Man overboard

Man over board accidents are most likely to occur on deck as a result of a slip/fall. MOB is a very critical situation and calls the need for emergency response. The chances of surviving a MOB situation depends upon a lot of factors. MOB mostly occur during ship-side activities and jobs such as ship-side washing, paining, working aloft, working outboard. If immediate help is not provided, it can result in the loss of life.

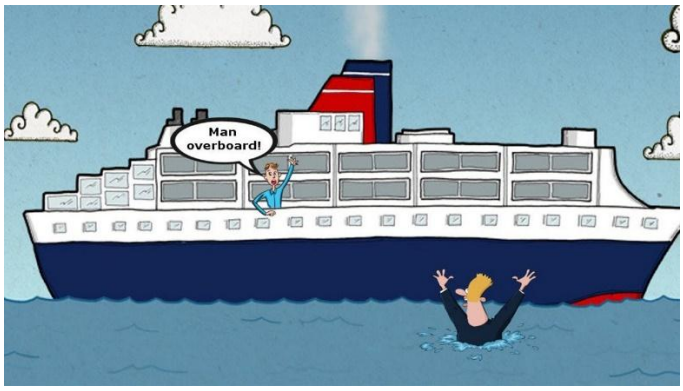

Figure 3.2.1 Man overboard diagrammatical representation

3.3 Fire

Fire on board ship is one of the most serious risks for personnel and property, as well as for the surrounding environment. On board ships there are tons of liquid fuels, electrical equipment, air-conditioning plants, engine boilers, stores of flammable material and crew accommodation areas that can be the reason which caused the fire. If it is not identified in time and the necessary action is not taken, it can cause explosion which results in the loss of both life and property.

Figure 3.3.1 Fire Fighting on Deck

3.4 Workshop injuries

There is a lot of repairing and maintenance work that is to be done on the ships and it therefore requires working in the workshops for many hours. If there is even a little mistake, it can be fatal to the person's life because the equipment that are used to do the work are very dangerous in nature and require the utmost carefulness when being used. If proper care is not

taken while handling the equipment, the resulting consequence could lead to injury/loss of body parts or can even cause death.

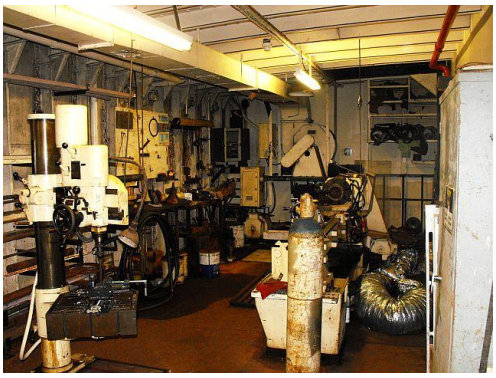

Figure 3.4.1 Depiction of a Workshop on ships

3.5 Getting trapped in a Confined space

This accident is basically due to the carelessness which mainly involves not following the proper procedure that is required to be followed before entering the confined space or due to lack of activeness of the mind. Excessively high temperature and/or limited oxygen supply can be dangerous to an entrapped person. On some earlier voyages, this has even resulted in the loss of life.

Figure 3.5.1 Confined Space Example

4.0 ACCIDENT PREVENTION AND DETECTION

Apart from the Personal Protective Equipment (PPE) there have been some other inventions that help to detect, if not completely prevent, some of the accidents that may happen on the ships. A few of them are as under:

4.1 Puretech's Man Overboard Detection and Monitoring system

Ships are constantly subjected to climate and weather changes and as a result a lot of listing moments develop. This becomes very dangerous as the ship enters deep sea waters and those conditions result in higher chances of a person falling over.

The problem is that when these events occur, the timely availability of important data is missing. Accurate confirmation of the event including time of occurrence, location on the

ship and location in the sea is critical, but often unavailable for hours following an occurrence, if at all. Until the recent past, such an event was verbally notified but in 2010, the United States' Government identified the need for increased measures to prevent MOB situations most importantly for the cruise ships. Fortunately, such a system can accurately detect man overboard events and provide immediate, actionable data to response personnel.

4.1.1 Details of the MOB system

PureTech Systems currently addresses the issue of man overboard detection through the use of intelligent video technology. Its MOB system captures images using thermal cameras surrounding the ship's perimeter, extending from the lowest deck to the waterline.

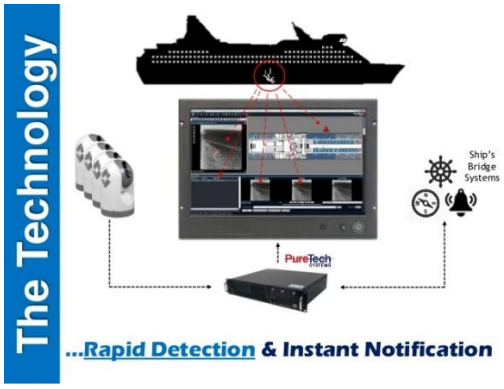

Figure 4.1.1 Components of a MOB System

4.1.2 Working

Systems utilizes a patented approach using geospatial video analytics and pairs of thermal imaging cameras which face each other. The synchronized video clips are then used to not only accurately detect a fall, but also to ignore environmental interference, background imagery from various sea states and shoreline views as well as avoiding false alarms due to normal operating conditions such as blowing debris, crew operations and other deck activity.

Key components of the solution, including the ability to determine an object's real size, classification, location, speed and trajectory – confirmed via synchronized data from the two independent camera views. When used in this manner, the type of the object (human, boat, etc.) used, along with location data, speed, trajectory and background modelling successfully determines if a person is moving upward, onto the ship or downwards. If downwards is the case, the system can provide a video-based anti-boarding alarm for verification and immediate action by the crew.

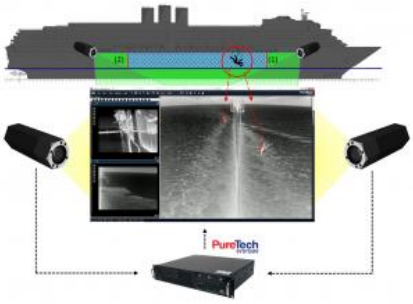

Figure 4.1.2.1 Working of a MOB System

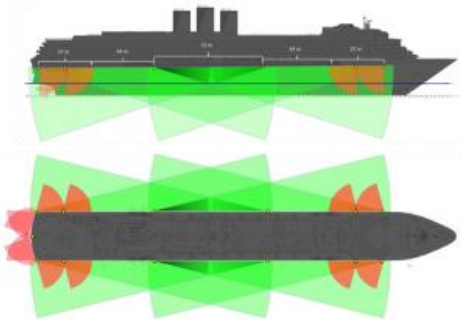

Figure 4.1.2.2 Range of Detection

The solution also has the capability to identify and suppress alarms on events which may exhibit traits of an anti-boarding event, but in fact are a result of normal crew operation, such as a worker performing maintenance on the outside of the vessel.

In a nutshell, it is a very useful system but the drawback is that when the expenditure becomes too high, this type of luxury is generally not included. Therefore, certain effective cost effective measures are still under R&D.

4.2 SawStop

4.2.1 What is a SawStop?

SawStop is a table saw that feature a patented automatic braking system that stops the saw within milliseconds if its blade comes in contact with the operator's hand or other body part.

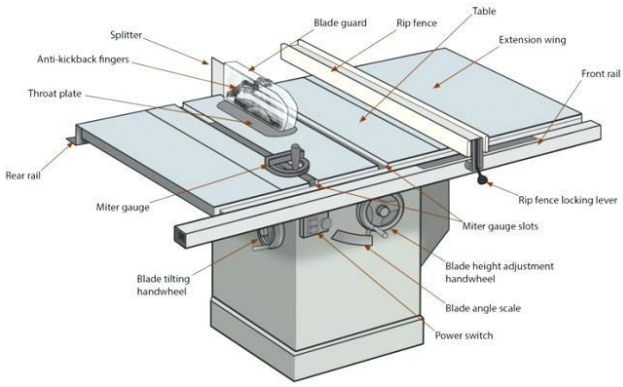

Figure 4.2.1.1 Diagrammatic Representation of a SawStop Table Saw

4.2.2 Working

The basic functioning principle it obeys is that the human body conducts electricity. SawStop's saws apply a small amount of electric voltage to the blade of the saw. The current through the blade is continuously monitored. If the saw detects a change in this current (as would occur if a hand or other body part came into contact with the blade), an automatic braking system is activated, forcing an aluminium brake block into the blade. This aluminium block is designed to absorb the energy of the blade by deforming.

4.2.2.1 Contact detection subsystem

The SawStop saw was designed to reliably detect flesh contact, with few false alarms. An oscillator generates a 12-volt, 200-kilohertz (kHz) pulsed electrical signal, which is applied to a small plate on one side of the blade. The signal is transferred to the blade by capacitive coupling. A plate on the other side of the blade picks up the signal and sends it to a threshold detector. If a human contacts the blade, the signal will fall below the threshold. After signal loss for 25 micro seconds (µs), the detector will fire.

Figure 4.2.2.1.1 SawStop's Blade

For instance, a tooth on a 10-inch circular blade rotating at 4000 RPM will stay in contact with the approximate width of a fingertip for 100 µs. The 200-kHz signal will have up to 10 pulses during that time, and should be able to detect contact with just one tooth.

4.2.2.2 Firing subsystem

When the brake activates, a spring pushes an aluminium block into the blade. The block is normally held away from the blade by a wire, but during braking, an electric current instantly melts the wire, similar to a fuse blowing.

Figure 4.2.2.2.1 SawStop's Braking System

After the whole system has been disengaged, it can easily be set up by replacing the blade and the brake cartridge.

4.2.3 Scope

The scope of such a device is that the concept can be applied to other workshop equipment as well which include, but is not limited to the following:

- Lathe Machines
- Drilling Machines
- Milling Machines

4.3 Personnel Positioning System

4.3.1 What is a Personnel Positioning System?

It is a system that can help to locate every person present on board and can keep the track of every person movement. Crew members exercise extreme caution on the ship but sometimes they tend to become careless, not intentionally but they do. So, the dangers that could occur thus should be avoided and if and when any such problem occurs, the precise location of the person could be pointed out thereby reducing the risk of the danger to life.

The idea is to provide a flooring on the decks that can register the movements of the people and send it to a centralised system which can account for every person's individual movements on the ship. It will be a specially designed arrangement which will have the necessary connections to indicate if a person walked over that specific part of the ship.

4.3.2 Structure

The body of the arrangement is a layer of low density polyurethane foam or a similar material with spaces in between to accommodate the pressure sensor. Polyurethane foam is a good insulator so when the outside temperatures change, the inside is not affected too much from it.

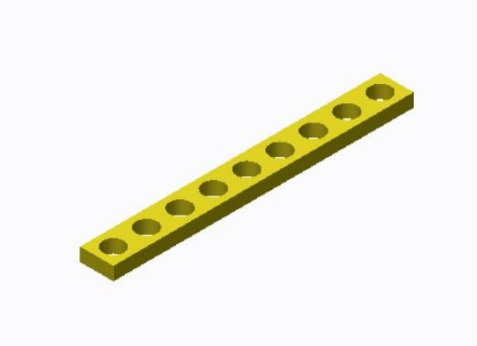

Figure 4.3.2.1 Foam Housing

The pressure sensor is a two-part device which is specifically designed to check the type and amount of force acting over it. The base and the top have separate switch heads which when come in contact will complete the circuit and allow the current to flow. A spring attached to the base helps the top to return to the initial position.

Figure 4.3.2.2 Pressure Switch Top

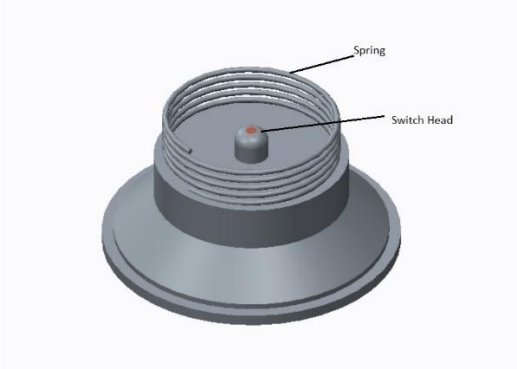

Figure 4.3.2.3 Pressure Switch Base

This whole arrangement is covered on the top with a sheet of high density rubber to prevent the oil or water to leak into the system.

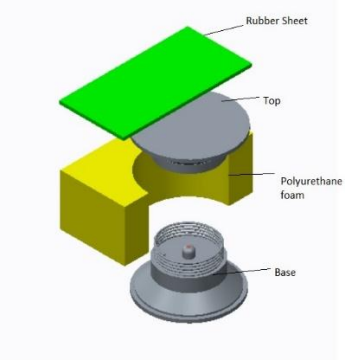

Figure 4.3.2.4 Arrangement

Figure 4.3.2.5 Switch Open

Figure 4.3.2.6 Switch Closed

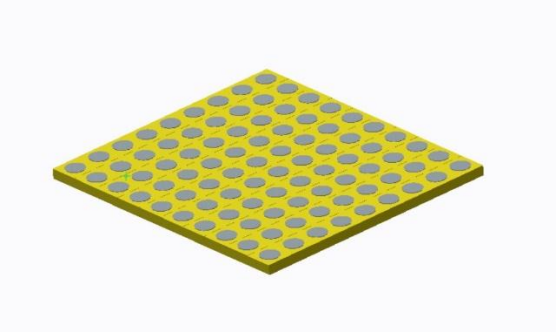

Figure 4.3.2.7 Overall Assembly

4.3.3 Working

The PPS operates at different levels which are mentioned as under

4.3.3.1 Positioning System

When a person will walk over a certain part of the deck, his weight will become the force that will compress that part of the floor. When this compression will take place, the switch heads will come in contact with each other. This will complete the circuit and the signal will be

relayed onto the computer system tracking this activity. As the system will have co-ordinate system relative to the ship, the precise location will be available depending upon which head numbers the person walked over and on which deck.

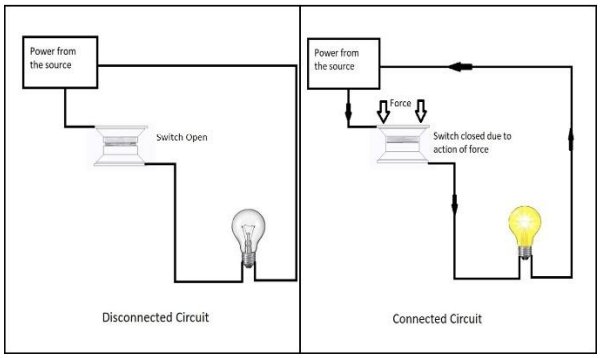

Figure 4.3.3.1.1 Circuit Diagram

So when an emergency arises, like if everybody did not report when the fire broke out, then the whereabouts can be made out from the last location that was registered.

4.3.3.2 Slip and Fall Detection

There are two types of loading that the pressure sensors are subjected to- gradual and impact. While the gradual loading aids in the positioning system, impact loading helps to point out the location where the accident took place.

The Strain developed in gradual load is given as under

$$\sigma_g = F/A$$

The strain developed in impact/sudden load is given as

$$\sigma_i = 2F/A$$

Where

σ_g= Strain due to gradual load

σ_i= Strain due to sudden/impact load

F= Force acting over the component

A= Area over which the force has acted

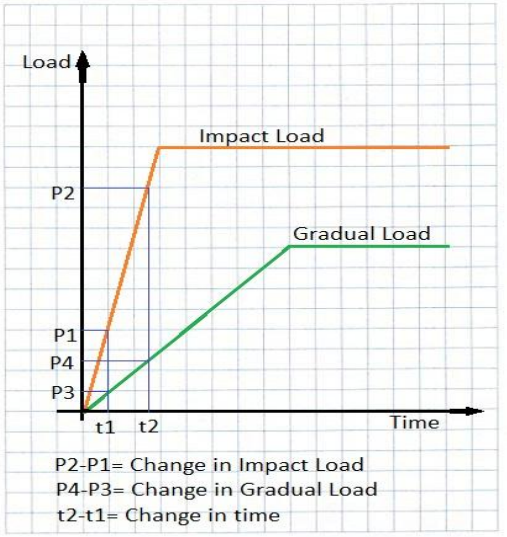

Figure 4.3.2.2.1 Load vs. Time graph comparing change in gradual and impact load for the same time period. Change in impact load is greater than the change in gradual load

So, the sudden change that takes place is the factor to differentiate between the sudden and gradual load that takes place and helps to easily point out the location of the incident.

4.3.3.3 Speed Monitoring

Although care is necessary when working on board, some areas do require a special attention and therefore have to be dealt with separately. A system like this can be used to differentiate the different areas on the ship depending on the level of danger that can happen there. So, when a person walks onto an area of danger, the person on the bridge or in the engine control room could be intimidated accordingly.

This is achieved by determining the speed at which the person is walking and what amount of load he is carrying and warning him whether he should walk with that speed, carrying said amount of weight in that specified area or not. The determination of the speed can be done using a simple mathematical formula as follows,

Suppose ‘p1’ is the point where the first pressure switch was activated, ‘p2’ is the point where the next activation took place and the time interval between the two points is ‘t’. So, the speed will be given as:

Speed= (p2-p1)/t

Where p2-p1 is the distance covered between two consecutive points.

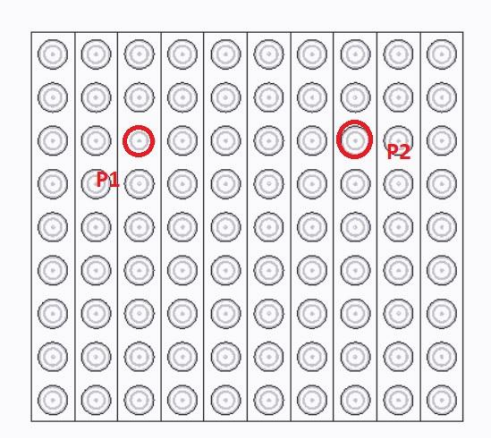

Figure 4.3.3.3.1 Diagrammatic representation of speed determination

One drawback of the whole system could be the cost effectiveness. If the expenditure has already been too much, the system may not be considered so there still is a lot of work that needs to be done to achieve better and cost effective means to achieve the said results.

5.0 CONCLUSION

PureTech Systems' Man Overboard Detection system has proved its effectiveness and as a matter of fact, it has been approved by the government of the United States of America and has been made a compulsion for installation on cruise ships of 65 passengers and above.

SawStops' have been responsible for preventing a lot of damage to the users all over. The consequent fatal damage has been reduced to a little scratch on the skin.

Personnel Positioning System, although a theory, can prove to be one of the best safety monitoring device. Not only in shipping industry, it can help to ensure safety in other areas as well like vault monitoring in the banks.

There is still a lot of development that has to take place to ensure better means of ensuring safety. But every little step is a step to achieving better means of safety. With every passing moment, there has been a development to take safety to a more dependable level. But it should never be forgotten or undermined that safety is a trait that comes from within the person. A person should be in-charge of taking care of his own self. Other things are but just the tools to help him ensure the safety. But if a person is not concerned about himself, then nothing possibly will be of any help to him. So, to ensure optimal Personal Safety, one shoul first and foremost make oneself aware of the dangers and how to prevent them by actively participating in workshops and undergoing training to inculcate safety habits as a part of reflex.

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