

# The surface vessel, an impregnable fortress or a sitting duck? On the importance of static and dynamic alignment of shipboard weapon systems.

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A navy's investments in ships and weapon systems represent billions of dollars. The most advanced shipboard weapon systems today perform a great number of concurrent tasks in terms of communication, combat and control with amazing intelligence and swiftness. Nevertheless, alignment and especially recurrent alignment are often regarded as second order issues or even neglected. From our experience, the reasons are partly that the subject is hard to grasp, partly that traditional alignment methods are troublesome to perform, and last but not least, the lack of insight of the real importance and necessity of alignment.



Two Visby class corvettes. Photo by Peter Nilsson/Kockums AB

## **No margin for poor alignment**

The effect of poor alignment can be truly disastrous. From detection of an approaching sea-skimming missile, there might be only a few seconds to react - and - fight it down. At least one shell out of a few possible bursts must hit the target or pass within the lethal radius (with proximity fuse) and, as there is no time for corrective action, the direction of fire must be right from the beginning.

In order to combat today's sophisticated missiles efficiently, which continuously manoeuvre during the flight, tracking and prediction of the trajectories must be nearly perfect. In the total error budget there is no margin for alignment errors in order to succeed. Since the threats can approach from any direction, it does not help if alignment is perfect in one direction only. That is why the elimination of tilt errors is so important.

Today, there is absolutely no excuse to be careless about alignment of the most critical parts of the weapon system i.e. the fire control directors, the ship's gyro and the guns. State-of-the-art alignment systems perform the measurements simpler and faster than ever before. The ship is afloat during measurements and there is a minimum of influence on the ship's routine. Certainly, to carry out alignment correctly still requires extensive knowledge of sensors, weapons, measurement technology and methods, but with the support provided by a modern alignment system it is significantly easier than before and the result is more accurate and reliable.

## **Why re-align a shipboard weapon system regularly?**

If the hull of the ship and the mounts of the sensors and weapons were stable over time, it would be satisfactory to perform complete alignment after installation of sensors and weapons once when the ship is new. However, in general it is not quite that simple.

## Hull deformation

The tolerance for misalignment between the fire control directors, the ship's gyro and the guns is very small and even if all naval ships are designed to sustain severe shocks, high impacts and loads, and minor damages, significant deformations can evolve over time. There are many different environmental factors to consider. Slamming, especially for small and slender ships, is one factor. Gun firing at low elevations, vibration from engines and shafts, whipping from own depth charges, temperature and replenishment cycles are some other. As a result, local plastic deformation may occur due to induction of stress or due to relaxation of stress in welding and bolted connections.

## How to detect malfunctions of the weapon system

Apart from hull deformation over time, the most important reason to perform alignment regularly is that possible malfunctions of transducers, electronics, servos etc might occur without detection or display of any error message. If so, the weapon system will not perform, as it should. What can you do about it? By carrying out static and dynamic alignment in a systematic way, you will not only minimise the alignment errors but also verify the most critical functions of the weapon system. During this work, an accurate and versatile alignment system can reveal and identify serious failures or malfunctions of the weapon system.

## Alignment intervals

Consequently, all navies should consider re-aligning at least the artillery systems (composed of fire control directors, ship's gyros and guns) annually and after replacement of sensors/weapons, major repairs and modification of fire control software.

For ships, staying away from the home base during longer periods, it is advantageous to be able to check-up of the director-gyro-gun system whenever desired without calling in the alignment specialists. For this purpose, there are easy-to-use alignment systems including gun cameras, which install in a few seconds. This type of equipment, today available in the market, enables quick trouble-shooting and verification of artillery systems in a way, which was not possible previously.

## Shipbuilders

The new technologies for static alignment apply to shipbuilding and ship repair as well. By installing and aligning all foundations and sensor/weapon platforms with the ship afloat, the ship can leave the slip or dry dock at an early stage. The cost savings potential is huge not to mention the increased flexibility.

## What equipment is required?

- Aligner 308 is a static alignment system designed for alignment of all types of sensors/weapons with the ship afloat. One system, serving a great number of ships, is required per base or per support ship.
- Aligner 224 is a dynamic alignment system designed for display, recording and analysis of video from multiple sources (directors and guns). One system, serving a great number of ships, is required per base or per support ship.
- Aligner 211, Aligner 221 and Aligner 231 are gun (boresight) camera systems designed for fast and frequent check-ups of the director-ship's gyro-gun system. One piece of equipment is to serve per ship.

All the equipment offers substantial savings of time and operational costs compared to traditional alignment tools and methods.

## Fortress or duck?

To perform the alignment tasks regularly for all ships concerned has shown to be less costly than expected thanks to the extensive support offered by our modern alignment equipment, and has led to a substantial increase of the overall accuracy and reliability of the weapon systems. In fact, our customers also perform alignment more frequently than anticipated, as the effort is quite reasonable in relation to the acquired confidence and reliability. By extension, correct alignment is probably the difference between being an impenetrable fortress or a billion dollar sitting duck.



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