Dr.Yuriy Batrak, November 2019, Intellectual Maritime Technologies

INTERACTIVE SHAFT ALIGNMENT AS A MEANS FOR UNCERTAINTIES OVERCOME

The Swedish Club statistics published in the third Main Engine Damage report (2018) show that the number of failures associated with ship propulsion does not decrease but even slightly increases.

4.3 Top 10 claims by cost for machinery claims, 2015-2017

Claims type	Number of claims	Average cost (USD)	Change in average cost % since 2010-2014
Main engine, excluding turbo charger	202	647,920	21%
Steering	25	572,920	53%
Propulsion	168	476,898	4%
Deck equipment, windlasses	16	456,468	150%
Crane and cargo gear	59	359,901	40%
Auxiliary engine, excluding turbo charger	112	345,823	2%
Boiler	18	334,939	0%
Turbo charger	76	291,191	-7%
Electrical equipment	43	267,924	22%
Lifesaving equipment	1	182,410	-10%

Undoubtedly various types of shaft alignment errors make a significant contribution to propulsion failures. And this happens despite the use of computer programs for calculating shaft alignment, the use of modern electronic devices to control the position of the shaft line during alignment procedure for vessels under construction or under repair. One involuntarily begs the question: what is the reason for such statistics?

There are some uncertainties and inconsistencies which do not allow exact matching the shaft alignment calculation and actual operating conditions of the shafting. Uncertainties and inconsistencies can be divided into three categories.

1. Uncertainties and inconsistencies that occur at the stage of shaft alignment design due to the lack of sufficient experience or qualifications of the designer, as well as the inability to accurately determine external factors. First of all, they are the incorrect assignment of the operating conditions in which the validity of shaft alignment should be checked; a rough estimate of the hydrodynamic loads on the propellers, especially in the case of twin-screw vessels; ignoring double bottom deformations during draft changes in the case of transport vessels; the lack of checking the stern tube bearing hydrodynamic lubrication regime, especially in the case of EAL use.

2. This category of uncertainty occur on the vessel, and objectively not allowing to develop an accurate shaft alignment plan. Such uncertainties arise when there are at least three bearings that cannot be accessed to measure loads; if it is not possible to determine the relative position of the propeller shaft and the output shaft of the gearbox or crankshaft of the diesel engine; in the absence of exact stiffness values of bearing and supporting structures; when final shaft alignment is performed in the dock conditions without simulating of buoyancy forces.

3. The third category of factors includes inconsistencies that occur during the implementation of the shaft alignment plan. They do not affect the shaft alignment procedure itself, but in the future may affect the shafting bending in operational conditions. Such factors include the mismatch of the weight

load on the double bottom during the shaft alignment procedure and weight assumed in the shaft alignment plan; mismatch of the real draft of the vessel to the values adopted when designing the shaft alignment plan; inconsistency of hull temperature deformations with the values assumed in the calculation.

It is difficult to overestimate the influence of the factors of the first category that determine the quality of the shaft alignment plan. These factors are determined by the level of engineering culture of the designer, his awareness of the state of scientific research in the field of shaft alignment, technical capabilities, and software at his disposal. The customer can exclude or minimize the influence of the factors of the first category only by choosing an authoritative designer.

It should be noted that the inconsistencies of the third category depend entirely on the shipyard. And, unfortunately, the circumstances of the shipyard do not allow to accurately fulfill all the requirements of the shaft alignment plan. Let us dwell in more detail on the uncertainties of the second category. To overcome this, the interaction of the company who performs calculations and the shipyard that implements the shaft alignment plan is necessary.

Uncertainties of the second category arise both from the design of the shaft line and from the specific conditions of the shaft alignment procedure at the shipyard, about which the shipyard informs the designer. As a result, it is necessary to make certain assumptions about the properties of the shafting model, which may or may not be confirmed in practice. The assumptions are correct if measured values are within shaft alignment plan tolerances. If all attempts to implement the shaft alignment plan and obtain the values of measured parameters within the tolerance range are unsuccessful, it is necessary to resort to the so-called interactive shaft alignment.

The interactive alignment is the interaction of the shaft alignment designer and the shipyard, in which the measured values of the alignment parameters from shipyard (jack-up test diagrams, bearing loads, SAG and GAP, bending stresses, shaft deflections) are transferred to the designer for analysis. Based on the measurement results, the designer identifies the actual properties of the shafting model that were uncertain during the calculation and makes an adjustment of the alignment plan. For this, the reverse calculation procedure is applied. With the ShaftDesigner software, this can be done very quickly and during the day an updated alignment plan can be transferred to the shipyard. If necessary, the following iteration can be performed. The process is repeated until satisfactory results are achieved. Analysis of the measurement results when using interactive alignment allows the designer to identify shortcomings in the shaft alignment measurements at the shipyard.

IMT company has a positive experience with the use of interactive alignment in remotely located shipyards. If the shipyard or consulting company providing shaft alignment has the ShaftDesigner software they can perform the iterative shaft alignment procedure on site.

In conclusion, it should be noted that all discussions regarding the uncertainties and discrepancies of the second and third categories are valid only if all problems with the uncertainties and discrepancies of the first category are solved with a sufficient degree of completeness.