Table of contents

Introduction

The target of alignment is to achieve positive static loads for all bearings (shaft line bearings and engine main bearings) under all normal ship service conditions, i.e. ship draught and trim within normal limits.

The propulsion shafts and main engine are directly coupled. Their foundation is an integrated part of the ship hull. Thus it is exposed to elastic ship hull bending which varies the offsets of bearings and thus their static loads. Further influences are service related forces and temperatures.

A basic pre-requisite to ensure a reliable operation of the propulsion machinery is a design with the propulsion shaft line bearings arranged at suitable distances. Such a design has well loaded shaft bearings with low static load variations.

The propulsion shaft line and the main engine are installed according to a case specific alignment layout calculation (ALC) which considers:

- the design of propulsion shaft line
- the design of the vessel
- the influence of ship hull bending
- rules and regulations of the governing bodies (e.g. class)

Before chocking and fixation of the main engine, alignment measurements are performed to proof that the alignment of the propulsion shaft line and the main engine complies with the referred ALC.

Further alignment measurements until ship delivery may follow, depending on specifications, rules and regulations, case specific class requirements, etc.

Abbreviations

The following abbreviations are used in this document:

ALC	alignment layout calculation
DG	design group (Wärtsilä drawing set structure)
mb	engine main bearing

1 Alignment in brief

The required steps for alignment are described below.
Also a flow diagram of the alignment process is provided in figure 1 for reference.

1.1 Project stage

1. Check for appropriate shaft bearing arrangement, optimise if indicated (see DG9709 - “Engine alignment – Bearing Arrangement & Layout Calculation“ - section “Shaft bearing arrangement / Optimum bearing distances”).
2. Create the ALC (see DG9709 - “Engine alignment – Bearing Arrangement & Layout Calculation“ - section “Alignment layout calculation”).

1.2 Before floating of the vessel

3. Finalise the engine assembly according to DG0351 - “Assembly Instruction”. Final alignment of main engine **cannot** be started if the engine assembly is not completed.
   From the beginning of re-assembly, **level the main engine bedplate carefully by means of all jacking screws** (or alignment wedges resp.).
   This is crucial for achieving proper static loads and crankweb deflections.
4. Install the propeller shaft and attach the propeller, incl. nut and cap.
5. Align the propeller shaft in relation to the stern tube.
   Make reference measurements – especially in case there is no forward stern tube bearing, i.e. reference measurements of the vertical and of the lateral propeller shaft position in relation to forward end of stern tube.
   These measurements are crucial to ensure a proper alignment of propeller shaft.
6. Install the stern seals.
7. Secure all shafts and the main engine against movement caused by forces during launching.

1.3 Afloat condition - before chocking the engine

8. Check alignment of propeller shaft by means of the reference measurements (as described in step 5) and re-adjust if indicated.
9. Align the intermediate shaft in relation to the propeller shaft by means of the gap & sag method (see DG9709 - “Engine alignment – Bearing arrangement & layout calculation“ - section “Shaft and engine alignment by gap and sag method”).
   In case of additional intermediate shafts, continue with alignment of the 2nd aft intermediate shaft in relation to the aft intermediate shaft.
   Continue progressively until also the foremost intermediate shaft is aligned.
10. Finally align the main engine in relation to the foremost intermediate shaft flange, also by means of the gap & sag method at the crank shaft aft end flange.
11. Couple all shafts and main engine and remove all temporary supports and the jack-down force.

12. Perform alignment measurements before pouring of the main engine's resin chocks. All these measurements need to be made right after each other and without any intermittent re-adjustment, i.e.:
    - Measure all crankweb deflections and verify them with DG9709 - "Engine alignment – Crankweb deflections - Limits" - section "Limits before chocking".
    - Perform jack-up tests for all shaft bearings (except the inaccessible aft stern tube bearing) and for the aft three engine main bearings mb #1 to mb #3[1].
13. **The measurement results can be sent to Wärtsilä for review (free of charge). Wärtsilä will analyse the data and either confirm them if satisfactory – or advice corrective measures if indicated.**
    Alternatively the evaluated shaft bearing loads can be verified with calculated static loads of ALC, cold - stopped condition and with DG9709 - "Engine alignment – Main bearing loads – recommendations & limits" - section "Recommended static main bearing loads before chocking".
    If limits are exceeded or in case of doubt about the correct alignment[2], re-adjust the alignment. If required, check the bedplate bending shape.

1.4 Afloat condition - chocking and fixation

14. Weld the side stoppers in position; but do **not** fit the side stopper wedges yet.
15. Pour the resin cocks under the engine (see DG9710 - "Engine Seating / foundation").
16. Install the chock(s) under the shaft bearing(s).
    Alternatively this step could be carried out after the engine is bolted down and alignment measurements made after chocking have indicated satisfactory results.
17. Bolt down the engine.
18. Install the side stopper wedges.

1.5 Afloat condition - before ship delivery

19. Alignment measurements before ship delivery: Wärtsilä recommends the same alignment measurements like before chocking, at least for the first vessel of a ship series.
    Verify the measured crankweb deflections with DG9709 - "Engine alignment – Crankweb deflections - limits" - section "Limits for commissioning / ship delivery".
    Verify the evaluated main bearing loads with DG9709 - "Engine alignment – Main bearing loads – recommendations & limits" - section "Required static main bearing loads before ship delivery".

---

1 In some cases a load measurement for additional main bearings might be required (see DG9709 -"Engine alignment – Main bearing loads – recommendations & limits" – section "Bearing load measurement").

2 If needed, please contact Wärtsilä for further support.

1.6 Afloat condition: after ship delivery / normal ship service

20. During normal ship service[3] the following checks are required:

- The service temperature of propulsion shaft line bearings need to be monitored.
  Inspections need to be done according to maker's advice or class requirements.
- Crankweb deflections need to be measured according to intervals listed in the maintenance manual of the main engine or by class rules - whatever is stricter.
- Crankcase and engine main bearings need to be inspected according to the maintenance manual of the main engine or by class rules - whatever is stricter.

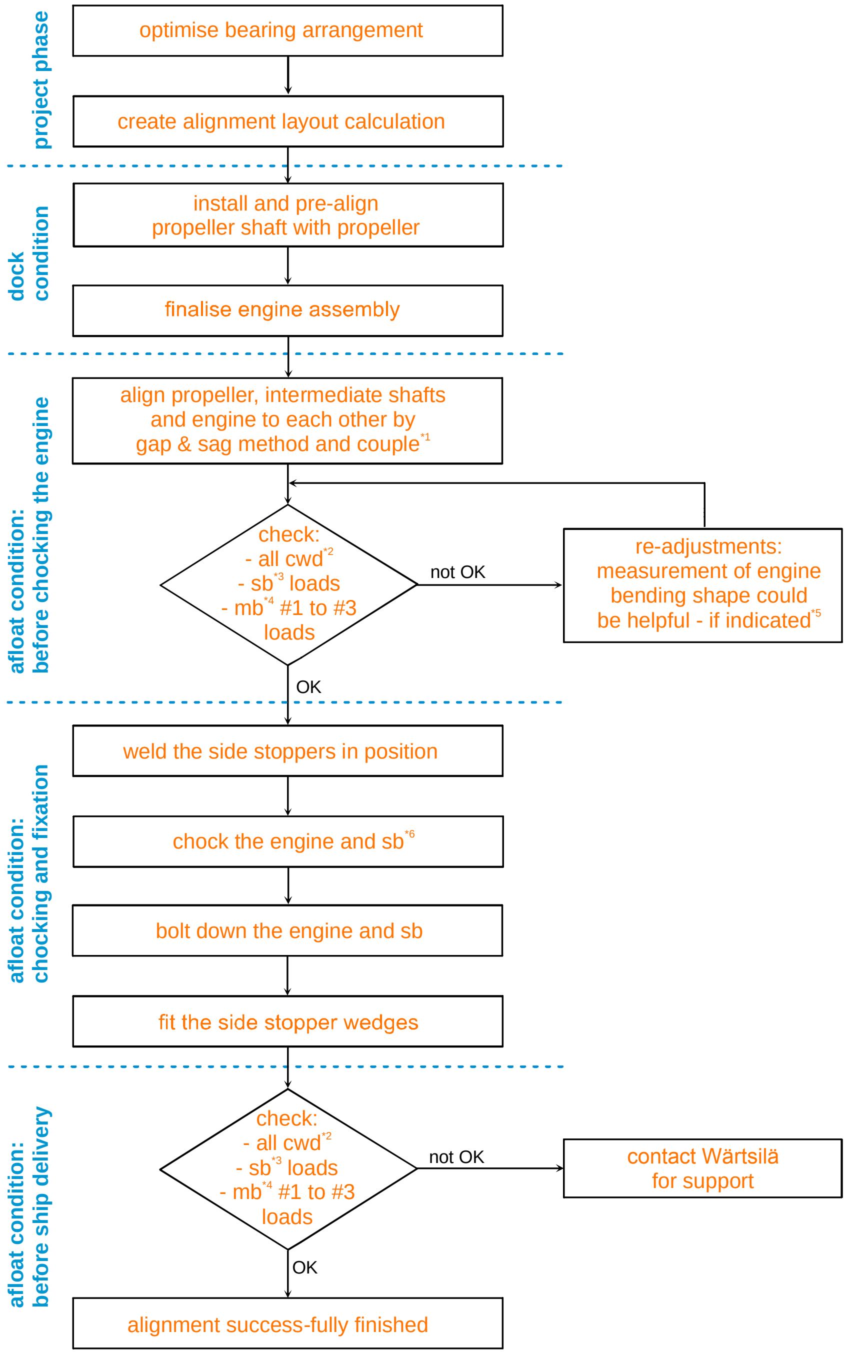
In exceptional cases, jack-up tests of main bearings can be required for root cause analysis of abnormalities which might be related to alignment, e.g. main bearing failure or extraordinary change of crankweb deflections. Relevant limits for main bearing static loads are provided in DG9709 -"Engine alignment – Main bearing loads – recommendations & limits" – section "Minimum limits for normal ship service".

1.7 Summary

All bearings need to be loaded under all normal ship service conditions!
Therefore:

- Influences on alignment are to be kept as small as possible, e.g. by arranging propulsion shaft bearings at optimum distances.
- Expected changes of bearing offsets from installation to any normal ship service condition need to be appropriately considered (pre-compensated) in the cold – stopped condition of relevant ALC according to which the propulsion shafts and the main engine are aligned during the installation process.
- A careful levelling of main engine bedplate by means of all jacking screws (or alignment wedges resp.) from the beginning of engine re-assembly in the shipyard until chocking of main engine is crucial for achieving proper static main bearing loads and crankweb deflections.
  Also the completely assembled main engine needs to be supported by the full number of jacking screws (or alignment wedges resp.) in order to avoid distortion.

[3] Ship service means: after ship delivery, ship fully afloat, draught between normal ballast and maximum draught (so called 'scantling'), normal trim, engine cold-stopped or warm-stopped or hot-stopped.



*1 according to alignment layout calculation and yard's experience
*2 cwd: crankweb deflection
*3 sb: shaft bearing
*4 mb: engine main bearing
*5 it is indicated if the reason for exceeding the limits is not clear
*6 if shaft bearings need to be chocked

Figure 1: alignment process flow diagram.

Substitute for: | PC | Q-Code | X | X | X | X | X

Modif	Number	Drawn Date		Number	Drawn Date		Number	Drawn Date		Number	Drawn Date

WÄRTSILÄ

Product **W-2S**

Engine Alignment
Alignment in brief

Made	14.10.2013	J.Bergande	Main Drw.	Page 5 / 5
Chkd	18.10.2013	W. Schiffer	Design Group **9709**	Material ID **PAAD128842**
Appd	21.10.2013	B.Haag		Drawing ID **DAAD040461** Rev

WinGD-2S - Alignment - in brief

TRACK CHANGES

DATE	SUBJECT	DESCRIPTION
2016-10-25	DOCUMENT	First web upload

Winterthur Gas & Diesel Ltd.
Winterthur Gas & Diesel AG.
Winterthur Gas & Diesel S.A.

Schützenstrasse 3
PO Box 414, CH-8401
Winterthur, Switzerland

Tel. +41 (0)52 264 8844
Fax +41 (0)52 264 8866