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# Practice Report

THYSSEN NORDSEEWERKE



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*Dimensional Control and Analysis at  
Thyssen Nordseewerke*

*Leica*

MADE TO MEASURE

# Dimensional Control and Analysis at Thyssen Nordseewerke



Picture 1: The DCA-TPS system in action at Thyssen Nordseewerke



Picture 2: The field computer with the on-board DCP10-software

## **TNSW – a yard with tradition**

Thyssen Nordseewerke GmbH, located in Emden on the North Sea coast, has a long tradition dating back to 1903, when the shipyard was founded as the "Nordseewerke Emdener Werft und Dock Aktiengesellschaft". Around 500 merchant ships, and 60 submarines and frigates have been built to date. With a staff of around 1,350, the yard is now one of the most modern shipbuilding enterprises in Europe, producing high-quality container ships, special vessels, icebreakers, frigates and submarines.

## **Shipbuilding technique**

At Thyssen Nordseewerke, ships are erected on the slipway. Parts and segments of up to approx. 350 tons unit weight are fabricated in the surrounding sheds, before the blocks are craned onto the slipway for erection.

"Best-fit" construction requires utmost precision in fabrication and measurement during all stages of manufacture. Production and quality control managers have thus opted to use the Leica DCA-TPS system for ongoing control and on-site measurement (Picture 1).

## **Survey reference system**

All measurements within the hull are based on the marked centre line or a reference line parallel to this and a predetermined "principle object point" for the second level co-ordinate. Markings on bulkheads, the water line or defined object points within the spaces provide references for level. In submarine construction, the main axis plane or centre plane is used in setting out. Special navigation or sonar components are set out using a primary reference line.

## **DCA-TPS measurement system – submillimetre accuracy**

While the two TDM5000 sensors and Husky FS/2 field computer (Picture 2) with the on-board DCP10 software comprise the field equipment, general dimensional analysis is performed using the DCP20 software. The precision total station measures with submillimetre accuracy: The typical distance measuring accuracy equals 0.5 mm up to 120 m distances.

Axyz CDM software is used for applications specific to submarine construction, e.g. to compute the roundness of individual segments of the pressure hull or to verify the cylindricality of the centre section and roundness of the spherical segments at either end of the hull.

These basic system components are backed up by a range of accessories used in measuring a variety of objects under difficult conditions. These include the hidden point rod, magnetic holder, vacuum holder, various types of standard target (Picture 3) and special tripods for positioning the TDM5000 at different levels.

### ***Use in merchant ship construction***

The systems are used in merchant ship construction for on-site measurement, also during the fabrication of individual parts and segments. The fundamental measurement task when constructing a new object is the establishment at the erection site of a co-ordinate system ("building frame system") with a reference plane to be used for positioning the first double-bottom hull blocks. The points of this co-ordinate system are marked or drilled so as to allow fixing of targets prior to measurement. During the setting out stage, measurements are recorded in a polar, tacheometrical system, before the program calculates the transformation to obtain the measured co-ordinates of the object points in the ship's co-ordinate system. After setting out, the first double-bottom blocks are positioned. Their centre line and other object points then become the new reference points and are used for measurements inside the hull, where the original reference points, now outside the hull, can no longer be sighted. The measurement systems are applied to each new segment added, to check the position of components in relation to each other and, if necessary, to facilitate remedial action.

### ***Top precision for dimensional control***

The positioning of bulk-heads requires particular attention (Picture 4). These are normally incorporated as single sections perpendicular to the direction of travel, delimiting the hold at bow and stern and splitting it into several sections for stowing purposes. In the hold area, the setting out in line and level of container foundations and the vertical container tracks used for loading are important measurement tasks requiring utmost precision to ensure easy loading and unloading and to prevent the movement of stowed cargo. Steps incorporated in the curved outer sections of the hull to exploit otherwise redundant space are fitted out in the same way as the main part of the hold to receive containers. Measurements to ensure that these steps are built parallel to the main floor are critical.

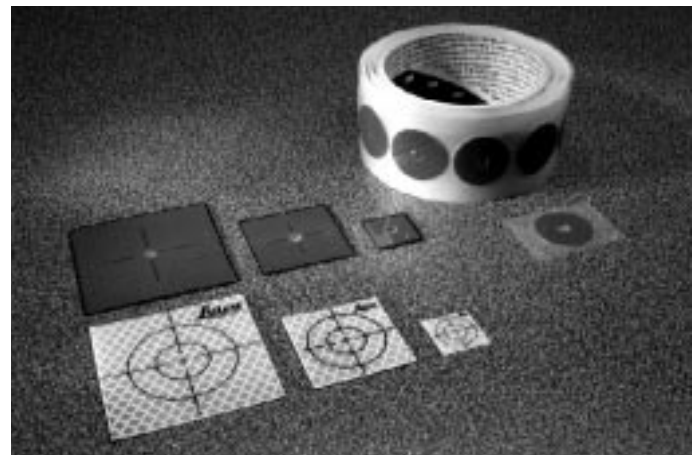
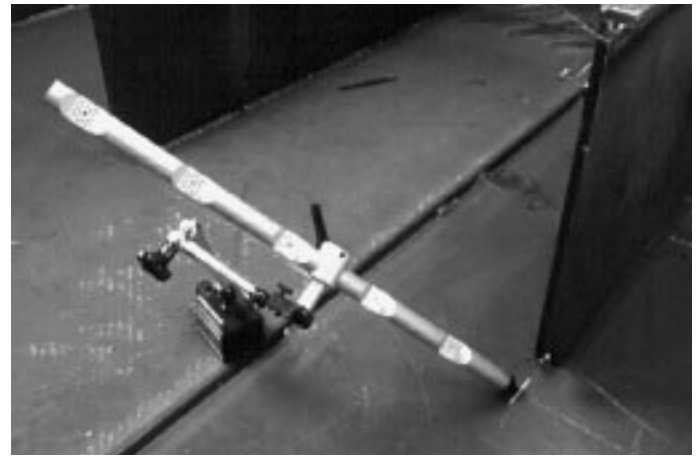
Another important measurement task concerns the setting out of machine foundations, fittings and drive unit, in particular the checking of shaft and rudder positions.

### ***Economic significance***

In 1995 the Thyssen Nordseewerke started phasing in "neat" production methods, i. e. precision fabrication with a minimum of excess material to be trimmed on site.

This method sets out to achieve a high degree of accuracy, within permissible tolerances, at all stages of production – burning, fabrication of sections and blocks – to make traditional excess material and trimming/reworking during erection unnecessary.

Strict implementation of this test system at all levels of production, supported by the Leica DCA-TPS measurement system, have thus considerably reduced erection times on the slipway.



***Picture 3: Accessories for targeting the points of interest***



***Picture 4: Control of the bulk head's position***



**Picture 5: Conventional, staff intensive method for roundness checks using a gauge (1D measurement)**



**Picture 6: Single operator 3D-roundness check using a total station (3D measurement)**



**Picture 7: Precision total station TDA5005 with radio modem for wireless data transmission**



**Picture 8: Laserpointer DL2 to visualize the 3D location on site according to design data**

### **Use in submarine construction**

The Leica DCA-TPS system (Picture 6) has recently been officially approved by the German Federal Armed Forces Procurement Office (BWB) in Koblenz as a third method for measuring the roundness of submarines, offering an alternative to the gauge (Picture 5) and compass measurement methods.

The current U212 series for the German Federal Navy will be the first to be produced at the Thyssen Nordseewerke with ongoing on-site measurement using the Leica DCA-TPS system.

Measurement of roundness using the total station obviates the need for the elaborate scaffolding required, for example, by traditional methods to ensure safe and accurate handling of the heavy, bulky measuring devices. The total station simply requires a small target (reflective tape on suitable carrier) of small weight (approx. 100 g) to be taken to the individual measurement points; while one man moves around the object, another operates the measuring device, positioned on a sound base at a convenient distance from the object. The location of the measuring device largely depends on the visibility of the measurement points and the ambient conditions on site. Flexible positioning of the system allows the user to select those locations that cause minimum disruption to site operations. Compared to the compass measurement method, which can only be used as long the hull has not been

fitted out, the total station has the advantage of allowing measurement of partially or totally fitted objects.

Other operations carried out on submarines at Thyssen Nordseewerke include the setting out of external fixtures and measurements for special fittings inside the pressure hull.

### **New products and enhancements**

The functions of the TDM5000 motorized precision tachometer described above are available with the current TDM5005 and TDA5005 models (Picture 7), which are thus able to boost measurement accuracy. With the TDA5005, the outlined functions are further enhanced by Automatic Target Recognition (ATR). The use of prism targets allows automatic adjustment of the reflector and tracking as the reflector moves. Used in conjunction with remote control (Picture 7), this becomes a single-operator system.

Adaptable DL2 or DL3 diode laser pointers (Picture 8) are used to visualize the target line or point on the measurement object, further increasing setting out efficiency.

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