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MARITIME SAFETY COMMITTEE 98th session Agenda item 17	MSC 98/17/1 2 March 2017 Original: ENGLISH

IMPLEMENTATION OF INSTRUMENTS AND RELATED MATTERS

Consistency of In Water Survey (IWS) provisions for passenger and cargo ships

Submitted by the International Association of Classification Societies (IACS)

SUMMARY

Executive summary:	As requested by III 2, this document provides technical data regarding rudder bearing clearances on cargo and passenger ships; and proposes that III 4 be tasked to prepare draft amendments to the Survey Guidelines under the HSSC to waive the requirement to take measurements of the rudder bearing clearances on cargo ships when the inspection of the outside of the ship's bottom is conducted with the ship afloat, as is permitted for passenger ships
Strategic direction:	5.2
High-level action:	5.2.1
Output:	5.2.1.17
Action to be taken:	Paragraph 9
Related documents:	III 2/9/3 and III 2/16

Background

1 The Sub-Committee on Implementation of IMO Instruments (III), at its second session, discussed document III 2/9/3 (IACS) regarding the consistency of the In Water Survey (IWS) provisions for passenger and cargo ships. In document III 2/9/3, IACS proposed to waive the requirement to take measurements of the rudder bearing clearances on cargo ships when the inspection of the outside of the ship's bottom is conducted with the ship afloat, as is permitted for passenger ships.

2 III 2, having considered the views that the survey regimes for passenger ships and cargo ships are different, and that more technical data regarding rudder bearing clearance is needed, invited IACS to submit more data supporting the proposed removal of perceived inconsistency between provisions for passenger and cargo ships to the MSC for its consideration as to whether this issue should be referred to other sub-committees (III 2/16, paragraph 9.17).

Discussion

3 In order to provide more technical data regarding measurements of rudder bearing clearances, IACS has collected this information from its members for both cargo and passengers ships, which was taken during the inspection of the outside of the ship's bottom. A detailed analysis was then conducted to determine the average progression of the clearance of the rudder bearings between two subsequent surveys, at intervals of five years, which were taken when the ship was out of the water. The scope of the analysis aimed to assess if:

.1 the progression of rudder bearing clearances on cargo ships is comparable to that on passengers ships; and

.2 the progression of the average of the rudder bearing clearances on cargo ships in a five-year period is such that it is demonstrated that the measurements need not be taken at alternate inspections of the outside of the ship's bottom when the ship is afloat, as allowed by paragraph 4.6.2.2 of the *Survey Guidelines under the Harmonized System of Survey and Certification (HSSC), 2015* (resolution A.1104(29)).

4 IACS examined the very significant amount of data that had been provided by its members and calculated the average clearance progression lines for passenger and cargo ships. For cargo ships, the analysis was conducted by considering the main types of cargo ships such as bulk carriers, containerships, oil tankers and chemical tankers. The results of this analysis are presented in the report annexed to this document.

5 IACS noted that:

.1 the progression of rudder bearing clearances for each type of ship can be considered independent of the diameter of the rudder stock;

.2 the lines representing the progression of the average rudder bearing clearance on passenger and cargo ships are comparable; and

.3 the "to be expected" five-year progression of the rudder bearing clearances can be well predicted.

6 In this context IACS concluded that, for cargo ships, an interval of five years between two consecutive rudder bearing measurements can be considered as sufficient, since it is always possible to:

.1 make a reliable prediction of the expected rudder bearing clearances at the end of the next five-year period, on the basis of the last measurements that were taken; and

.2 compare the expected clearances with the acceptable limits fixed for any type of rudder stock material/ bearings material and decide whether there is a need to take "exceptional" sets of measurements at the occasion of the alternate outside inspections of the ship's bottom.

Proposal

7 In light of the results obtained from the analysis and considering that the matter is purely linked to survey activities, which is within the purview of the III Sub-Committee, IACS proposes that III 4 be tasked to review the Survey Guidelines under the HSSC, with a view to dispensing with the requirement to measure the rudder bearings clearances on cargo ships, when an inspection of the outside of the ship's bottom is carried out afloat.

8 This proposal would align the provisions for cargo ships with those for passenger ships, for which the measurement of the rudder clearances may be waived when the inspection of the outside of the ship's bottom is conducted when the ship is afloat (see paragraph 5.1.7 of the annex to MSC.1/Circ.1348 on *Guidelines for the assessment of technical provisions for the performance of an in-water survey in lieu of bottom inspection in dry-dock to permit one dry-dock examination in any five-year period for passenger ships other than ro-ro passenger ships)*.

Action requested of the Committee

9 The Committee is invited to note the information provided, consider the proposal in paragraphs 7 and 8, and take action as appropriate.

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ANNEX

REPORT ON RUDDER BEARINGS CLEARANCES INVESTIGATION

1 Introduction

1.1 The present report contains an analysis on the rate of increasing clearances in the steering systems of seagoing ships during their normal service.

1.2 Due to existing differences in technical requirements for passenger ships and cargo ships as regards the frequency of their bottom survey carried out in a dock, the analysis is aimed at verification of differences in steering system clearances mechanism measured onboard passenger ships and cargo ships.

1.3 The above-mentioned differences in requirements concern ships subject to SOLAS Convention and up to 15 years of age; therefore, the analysis covered passenger and cargo ships of at least 500 gross tonnage (GT) and up to 15 years of age.

1.4 The analysis was based upon information received from 12 Class Societies. In total, data from 580 measurements made onboard passenger ships and 5,400 measurements taken onboard cargo ships (1,300 from bulk carriers, 2,000 from oil tankers, 200 from chemical tankers, 600 from general cargo ships, 420 from gas tankers, 580 from containerships and 300 from other ships (ZZ ships)) were at disposal.

1.5 The analysis included ships for which at least three consecutive measurements of clearances in the steering system have been provided. Such data filtering made possible to define reliably the steering system clearance mechanism for a period of consecutive years. Single value measurement and those with not more than two values (current and previous) have been rejected. Such method made possible to formulate unambiguous conclusions which are presented in section 6.

1.6 The method of measurement values presentation has been given in section 2. In section 3, diagrams of clearance increase between consecutive measurements have been shown and a mean clearance increase within the interval of 2.5 years has been calculated. Section 4 presents the scatter diagram of consecutive clearance measurements and a trend line after averaging of all measurements.

1.7 The number of cases with clearance range exceeded, has also been determined.

1.8 The analysis of the so collected data allowed to formulate conclusions is presented in section 6.

2 The way of presenting results of the investigation

2.1 The way of presenting identified clearances (five consecutive clearance measurements) of the sample vessel (in this case passenger ship) is shown in table 1.

Last Visit Date	**Rudder Position**	**Max Clearance**	**Clearance**	**Survey Type**
20040608	PORT	0.60 mm	--	IWS
20061205	PORT	0.20 mm	-0.4 mm	DS
20090611	PORT	0.45 mm	0.25 mm	DS
20111024	PORT	0.45 mm	0.00 mm	DS
20130826	PORT	0.45 mm	0.0 mm	DS

Table 1

DS – means the clearance measurement in dry-dock.
IWS – means the clearance measurement afloat.

2.2 Figure 1 presents the identified clearance increase between the consecutive measurements for the sample vessel.

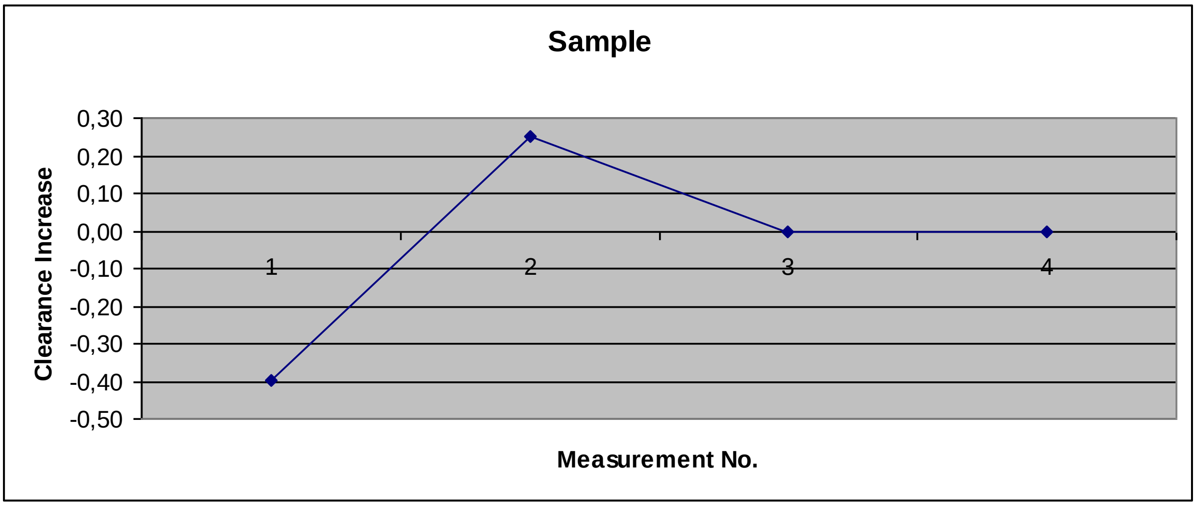

Figure 1

2.3 On the X axis is the measurement number. The first measurement from table 1 has the measurement number "0", as there is no previous measurement that it can be compared with. Point number 1 is the second measurement occasion. We can calculate the clearance increase, taking into account the first measurement and reflect it on the Y axis.

2.4 On the Y axis, we can find the difference between the present clearance and previous clearance [in mm]:

.1 at the first point, we can find that the present clearance is about 0.4 mm less than the previous one;

.2 at the second point, we can find that the present clearance is about 0.25 mm greater than the clearance measured on the previous occasion;

.3 at the third point, we can find that the present clearance at the same level as measured on the previous occasion – 0 mm clearance increase;

.4 at the fourth point, we can find that the present clearance at the same level as measured on the previous occasion – 0 mm clearance increase; and

.5 the time between measurements is more/less 2.5 years.

3 Identified clearance increase propagation

3.1 Passenger ships

3.1.1 The diagram of clearance increase propagation is given in figures 2 and 3:

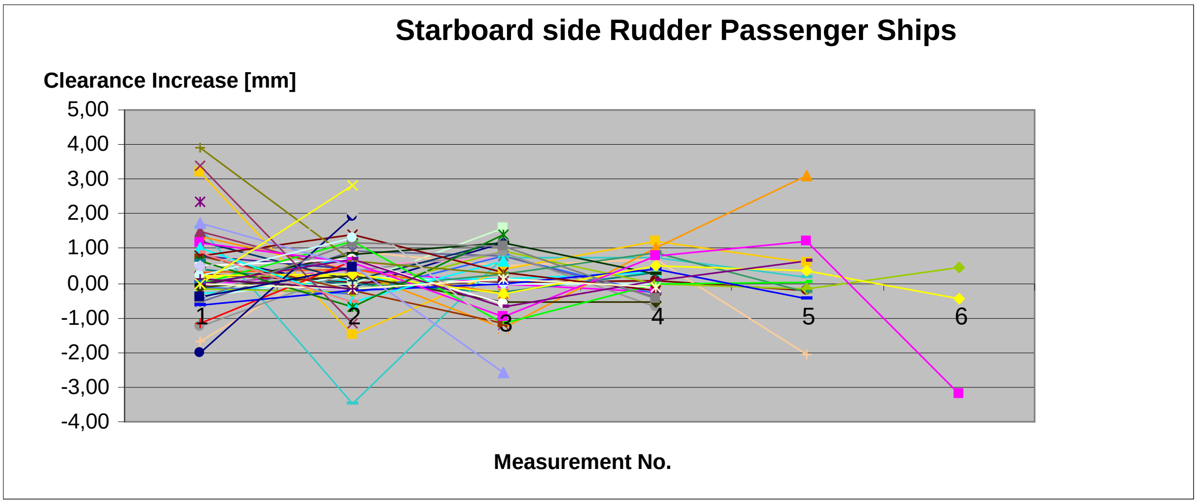

Figure 2

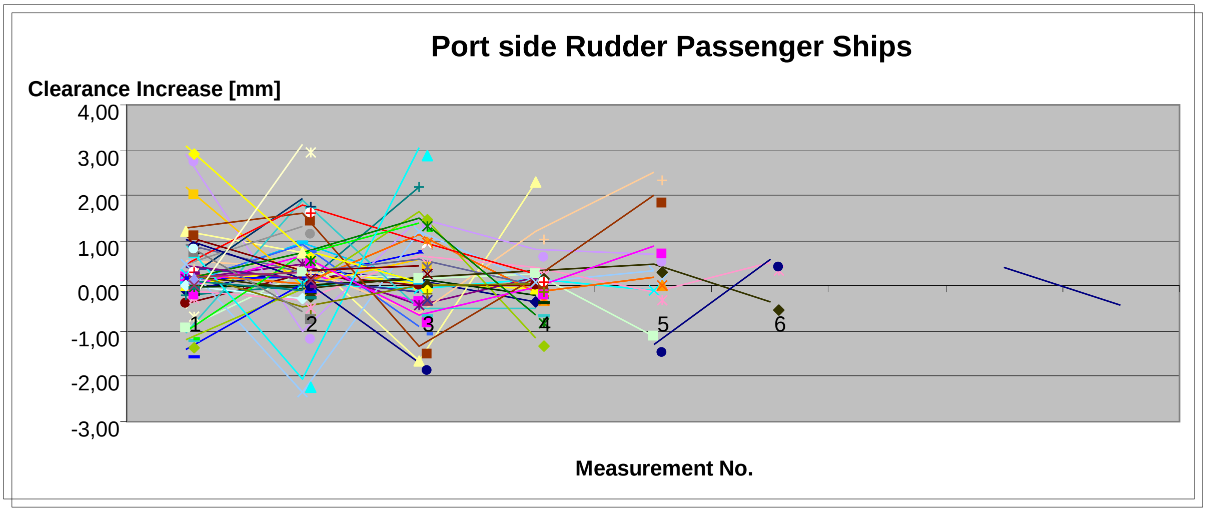

Figure 3

3.1.2 It may be observed that in many cases the clearance increase is a negative value – this means that the previous measurement was greater than the consecutive one.

3.1.3 Taking into account the above-mentioned facts, in order to receive a reasonable value of mean increase of rudder clearance, **only** measurements from dry-dock (DS), at five-year intervals, were taken into account. Measurements taken during in-water survey (IWS) were skipped. Considering the above outlined approach, it may be stated that the mean clearance increase on passenger vessels is as follows:

.1 for port side side rudders: **0.81 mm for a 5 year-period**

.2 for starboard side rudders: **0.76 mm for a 5-year period**

3.1.4 If we take into account all measurements (DS and IWS) the results are as follows:

.1 for port side side rudders: **0.0012 mm for a 2.5-year period**

.2 for starboard side side rudders: **0.0012 mm for a 2.5-year period**

3.2 Bulk carriers

3.2.1 The diagram of clearance increase propagation is given in figure 4:

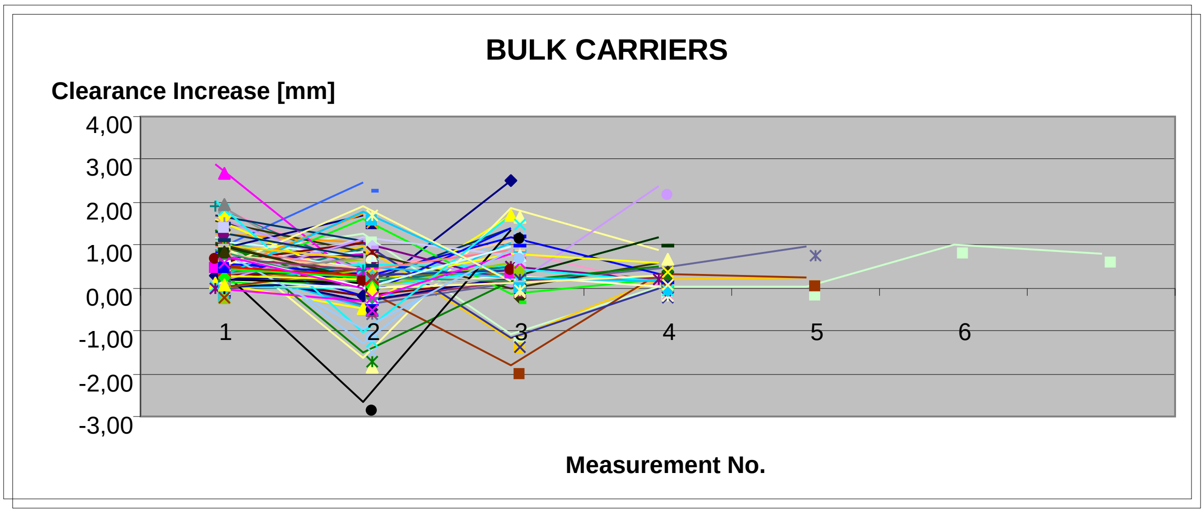

Figure 4

3.2.2 It is found that the phenomenon of negative increase is clearly visible, just as for passenger vessels. In the process of calculating the mean clearance increase, only measurements taken DS at five-year periods were taken into account.

The mean clearance increase of rudders in such a situation is:

- 0.63 mm for 5 years

3.2.3 If we take into account all measurements (DS and IWS) the results are as follows:

- 0.001 mm for a 2.5-year period

3.3 Oil tankers

3.3.1 The diagram of clearance increase propagation is given in figure 5:

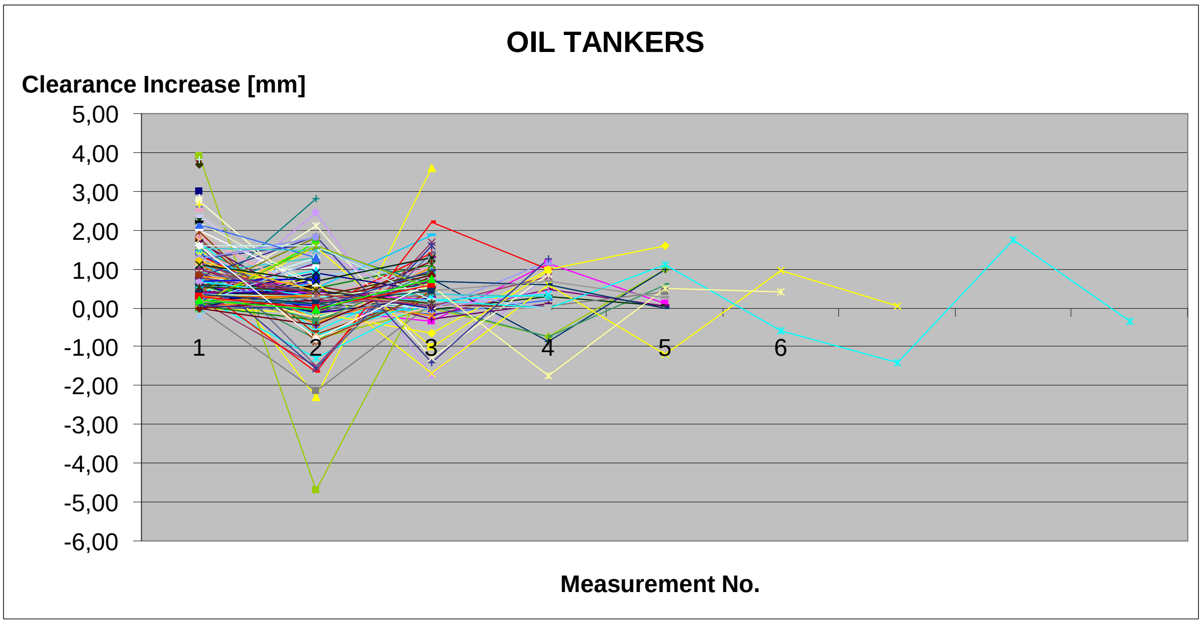

Figure 5

3.3.2 The results for oil tankers are comparable to the ones for bulk carriers. In the process of calculating the mean clearance increase, only measurements taken during DS at five-year periods were taken into account.

3.3.3 The mean clearance increase of rudders is:

- 0.75 mm for 5 years

3.3.4 If we take into account all measurements (DS and IWS) the results are as follows:

- 0.0002 mm for a 2.5-year period

3.4 Chemical tankers

3.4.1 The diagram of clearance increase propagation is given in figure 6:

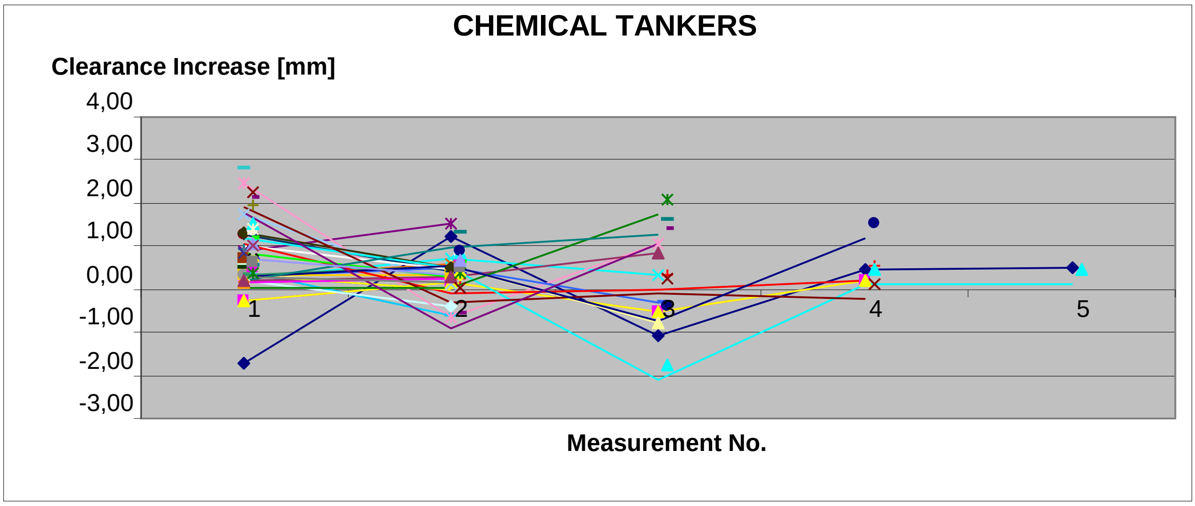

Figure 6

3.4.2 The picture is similar to the cases above, so in the process of calculating the mean clearance increase, only measurements taken during DS at five-year periods were taken into account.

3.4.3 The mean clearance increase of rudders is:

- 0.67 mm for 5 years

3.4.4 If we take into account all measurements (DS and IWS) the results are as follows:

- **-**0.004 mm for a 2.5-year period

3.5 ZZ type vessels (Tugs, Offshore Support, Cable Layers, Research Ships, etc.)

3.5.1 The diagram of clearance increase propagation is given in figures 7 and 8:

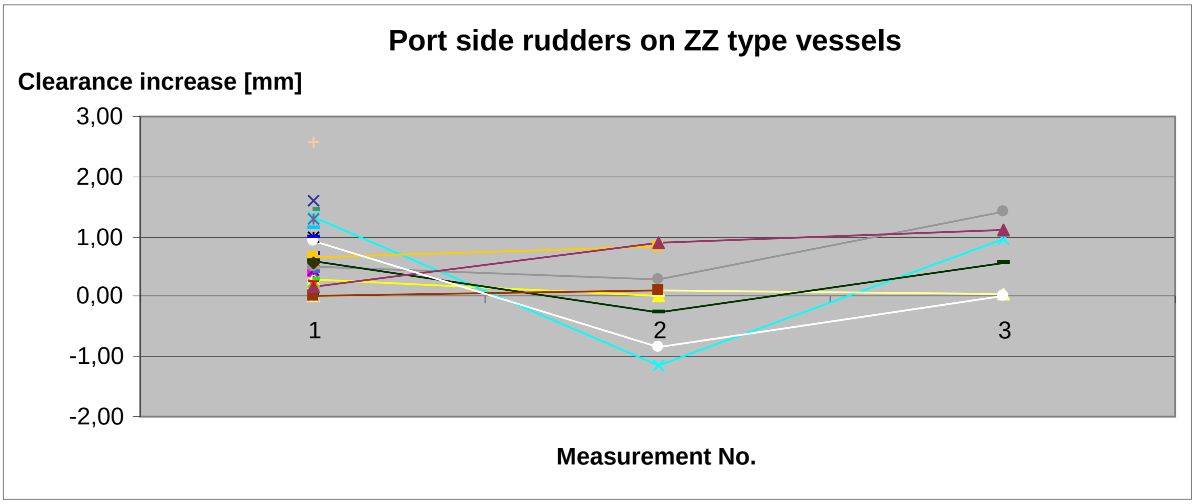

Figure 7

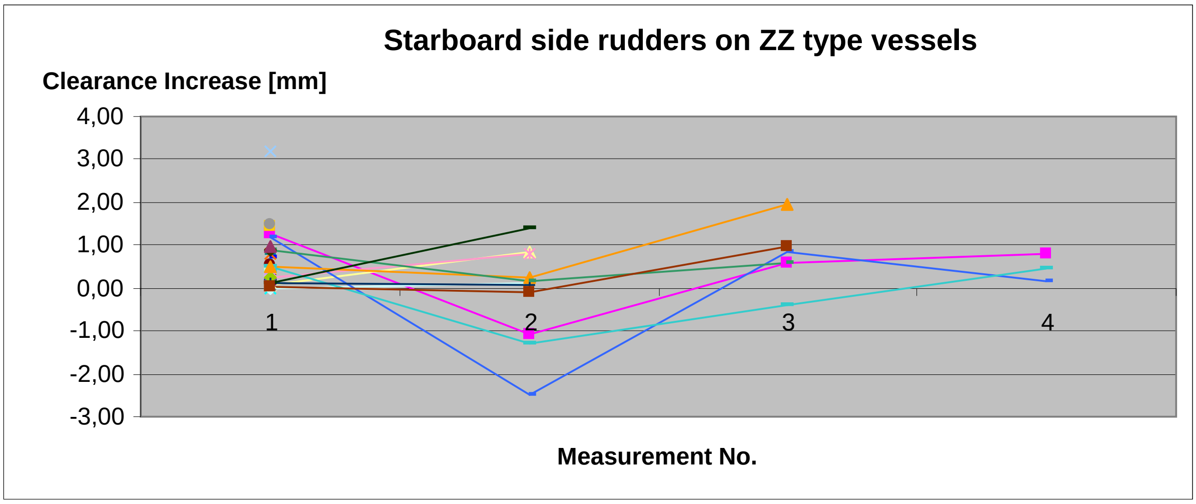

Figure 8

3.5.2 In the process of calculating the mean clearance increase, only measurements taken during dry-dock (DS) at 5-year periods were taken into account.

3.5.3 The mean clearance increase of rudders is:

- 0.75 mm for 5 years on port side
- 0.76 mm for 5 years on starboard side

3.5.4 If we take into account all measurements (DS and IWS) the results will be as follows:

- -0.002 mm for a 2.5-year period on port side
- -0.002 mm for a 2.5-year period on starboard side

3.6 General cargo ships

3.6.1 The diagram of clearance increase propagation is given in figure 9:

The plot of clearance increase propagation is given below:

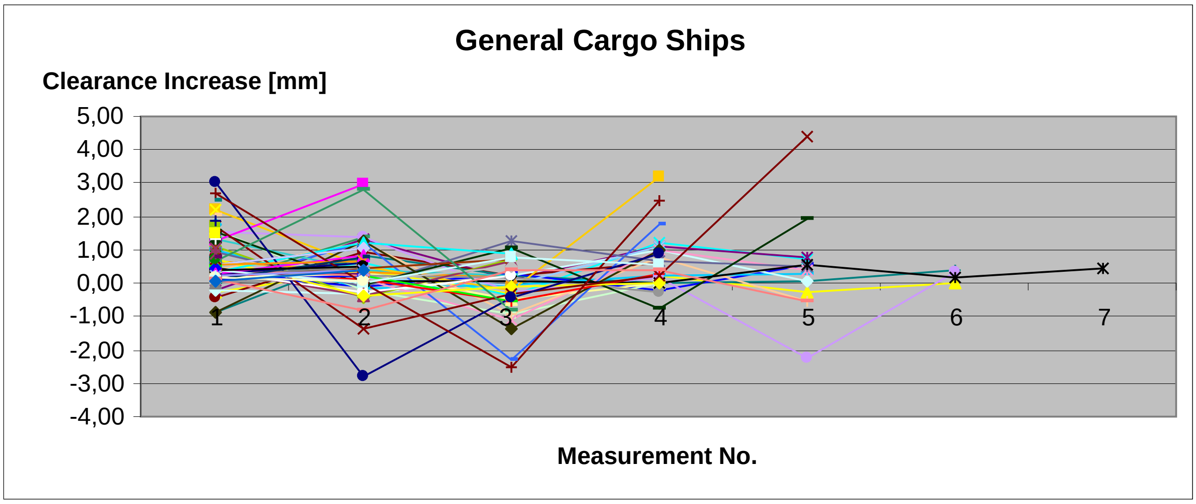

Figure 9

3.6.2 In the process of calculating the mean clearance increase, only measurements taken during DS at 5 year periods were taken into account.

3.6.3 The mean clearance increase of rudders is:

- 0.78 mm for 5 years

3.6.4 If we take into account all measurements (DS and IWS) the results are as follows:

- -0.0006 mm for a 2.5-year period

3.7 LNG and LPG ships

3.7.1 The diagram of clearance increase propagation is given in figure 10:

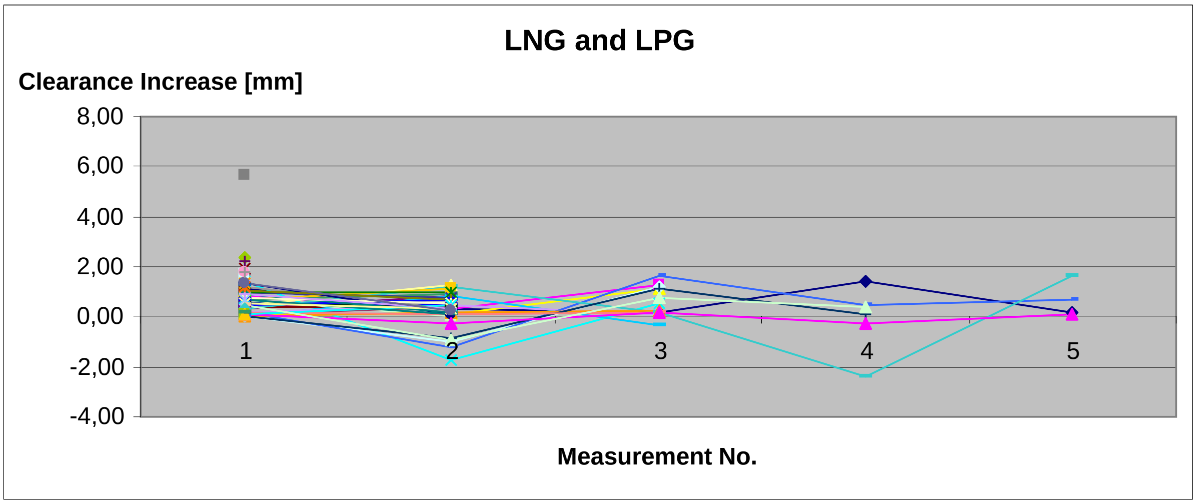

Figure 10

3.7.2 In the process of calculating the mean clearance increase, only measurements taken during DS at 5 year periods were taken into account.

3.7.3 The mean clearance increase of rudders is:

- 0.72 mm for 5 years

3.7.4 If we take into account all measurements (DS and IWS) the results are as follows:

- 0.0005 mm for a 2.5-year period

3.8 Containerships

3.8.1 The diagram of clearance increase propagation is given in figure 11:

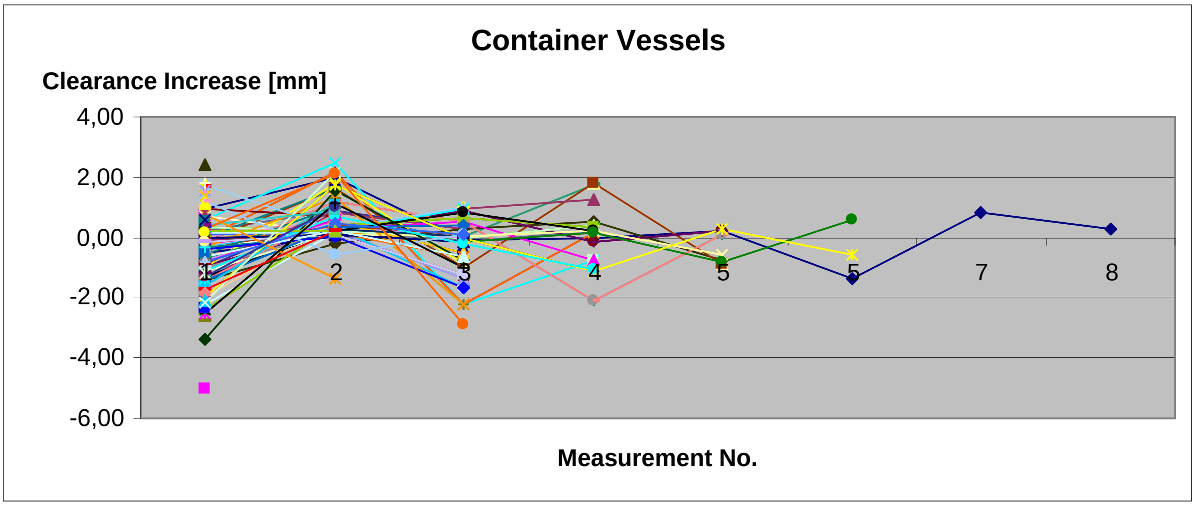

Figure 11

3.8.2 In the process of calculating the mean clearance increase, only measurements taken during DS at 5 year periods were taken into account.

3.8.3 The mean clearance increase of rudders is:

- 0.76 mm for 5 years

3.8.4 If we take into account all measurements (DS and IWS) the results are as follows:

- 0.001 mm for a 2.5-year period

4 Comparison of the mean increase of clearance values for different types of ships

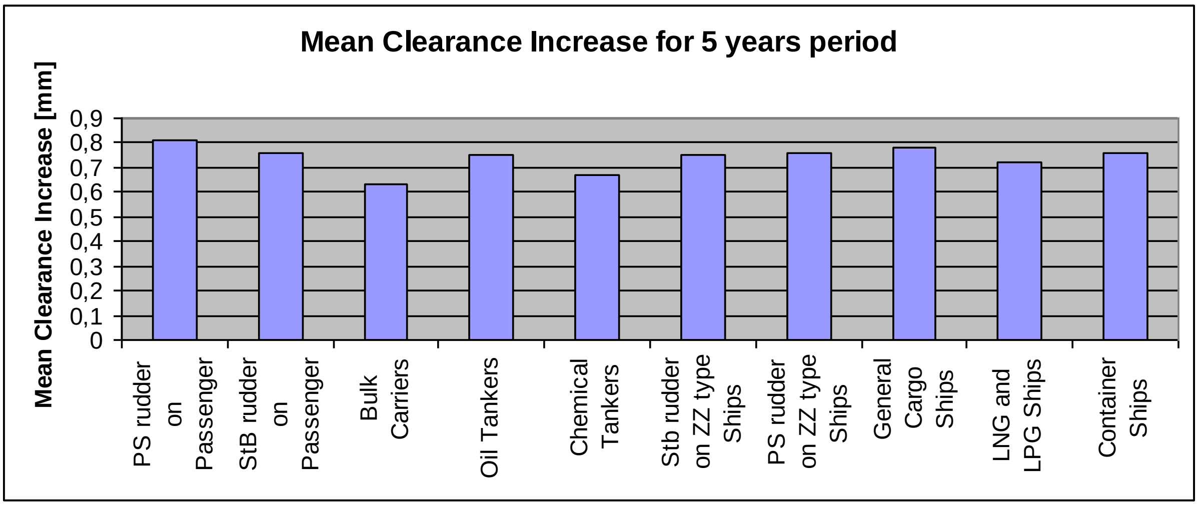

Figure 12

5 Identification of measured clearance exceeding the allowable limits

5.1 Determination of the allowable limits of clearances

5.1.1 Tables 2 and 3, as examples, provide the clearance limits of one of the IACS members for certain types of bearings.

5.1.2 Lignum vitae/synthetic bearing

Journal diameter [mm]	100	200	300	400	500	600	700	800
Clearance when repair is necessary	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
Clearance when repair is recommended	2.3	2.7	3.0	3.3	3.7	4.0	4.5	5.0
Initial clearance	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.5

Table 2

5.1.3 Stainless steel/bronze bearing

Journal diameter [mm]	100	200	300	400	500	600	700	800
Clearance when repair is necessary	**2.8**	3.5	4.1	4.8	5.5	6.0	6.0	6.0
Clearance when repair is recommended	2.3	2.7	3.0	3.3	3.7	4.0	4.5	5.0
Initial clearance	**1.0**	1.1	1.2	1.3	1.4	1.5	1.6	1.7

Table 3

5.1.4 It may be observed, that in the strictest case (diameter 100 mm, stainless steel/bronze bearing), the maximum allowable clearance increase is about **1.8 mm** (2.8-1.0=1.8).

5.2 The number of measurements where the measured clearance exceeds the limit according to the type of the ship

5.2.1 **General**

The data provided below was calculated based on the following assumptions:

.1 the clearance limit was established, according to the mean rudder stock diameter value for each analysed group of ships;

.2 the above-mentioned clearance limit was compared with each clearance measurement; and

.3 measurements were taken on a 2.5-year basis.

In each figure a trend line, which shows visually the average progression of the clearance along the years, was added.

5.2.2 Passenger ships

11 of 580 measurements; 1.8% cases

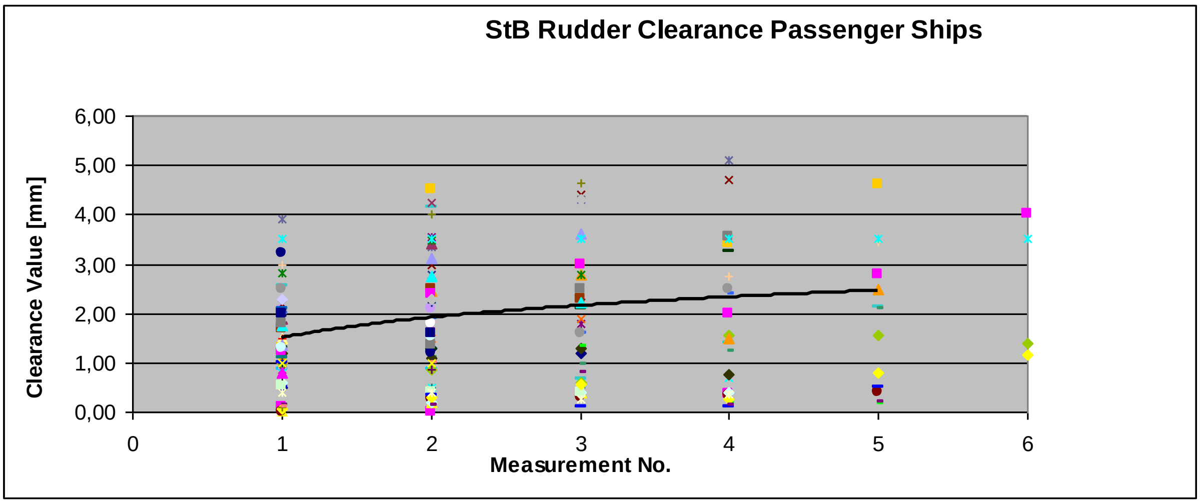

Figure 13

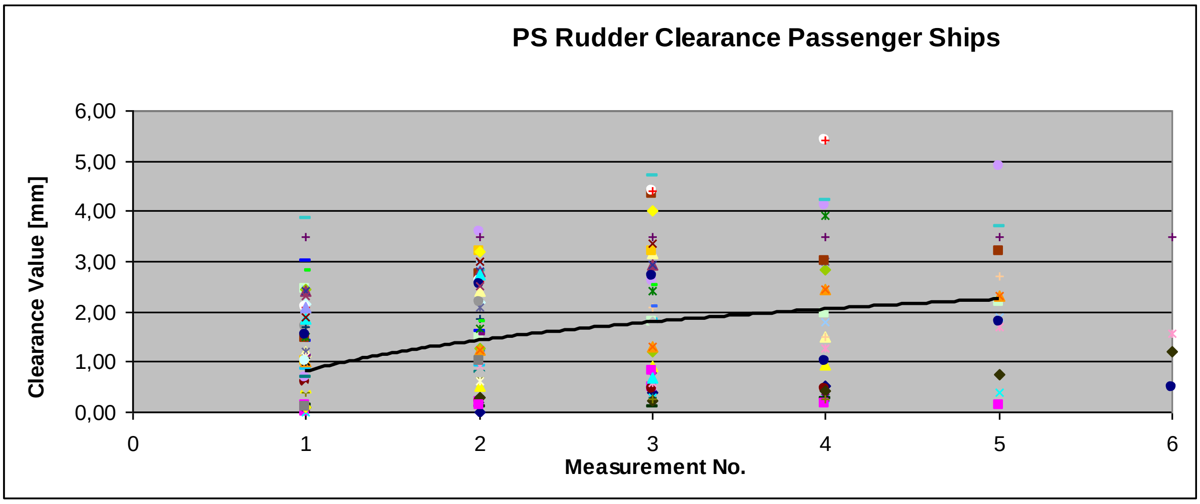

Figure 14

5.2.3 Bulk carriers

7 of 1,300 measurements; 0.53% cases

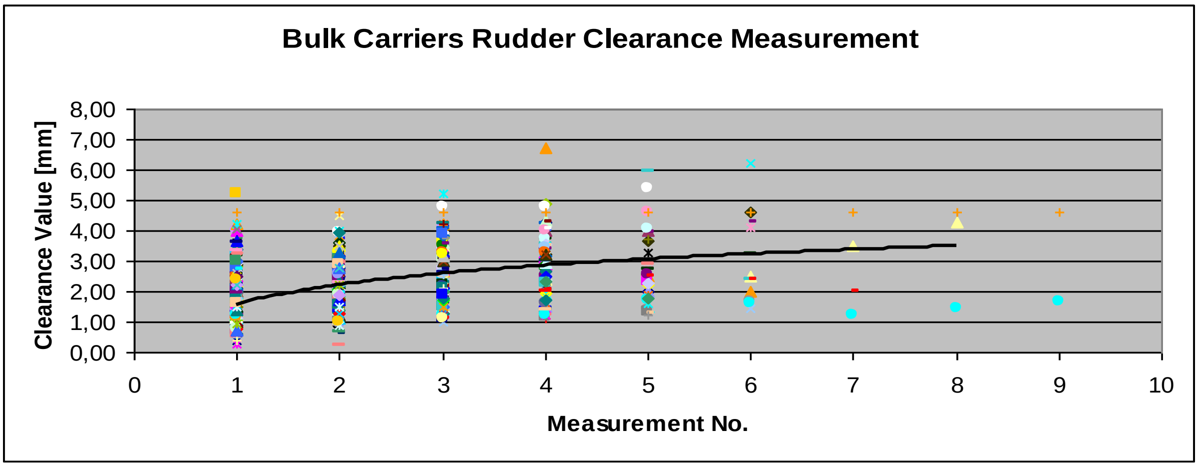

Figure 15

5.2.4 Oil tankers

7 of 2,000 measurements; 0.35% cases

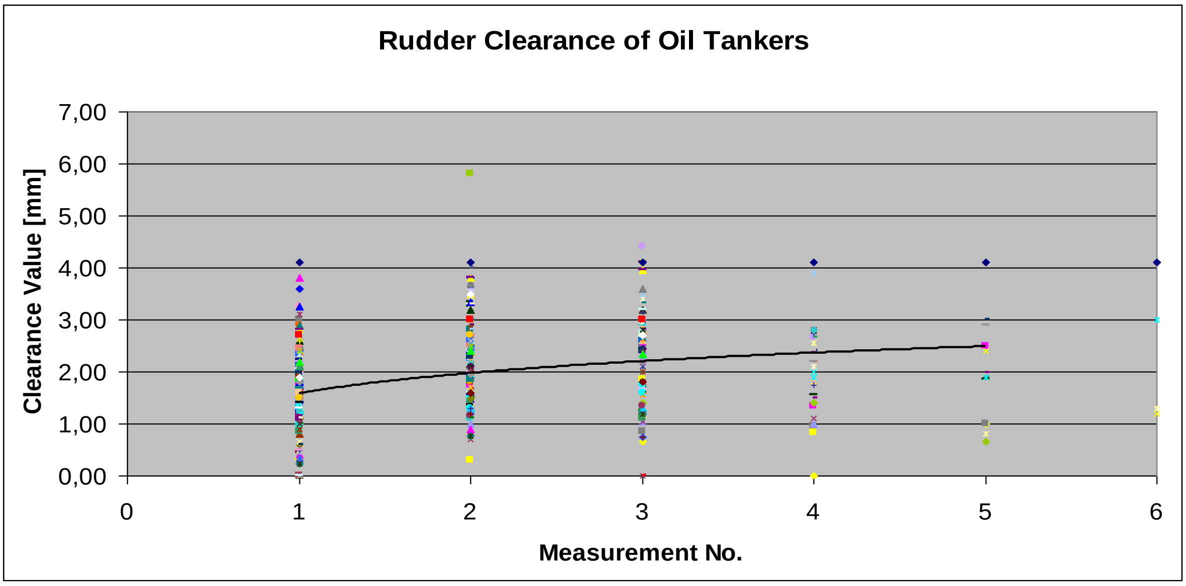

Figure 16

5.2.5 Chemical tankers

1 of 200 measurements; 0.5% cases

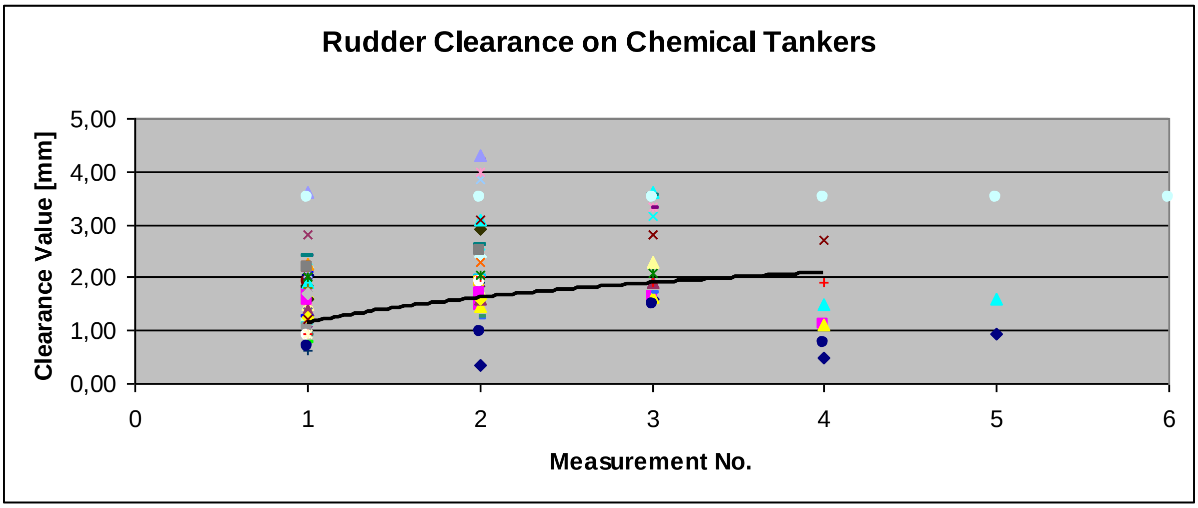

Figure 17

5.2.6 ZZ type vessels

2 of 300 measurements; 0.6% cases

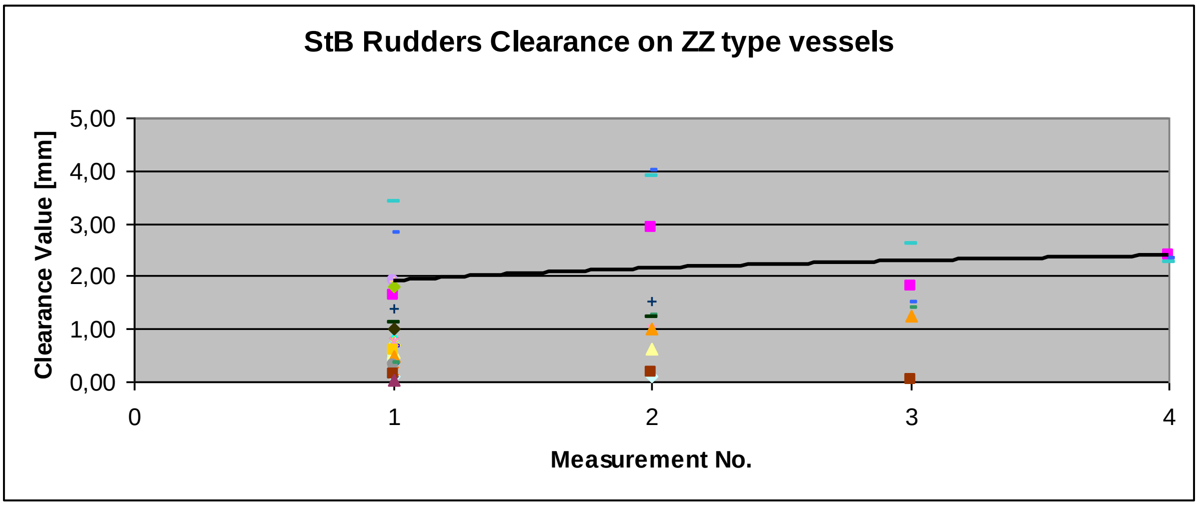

Figure 18

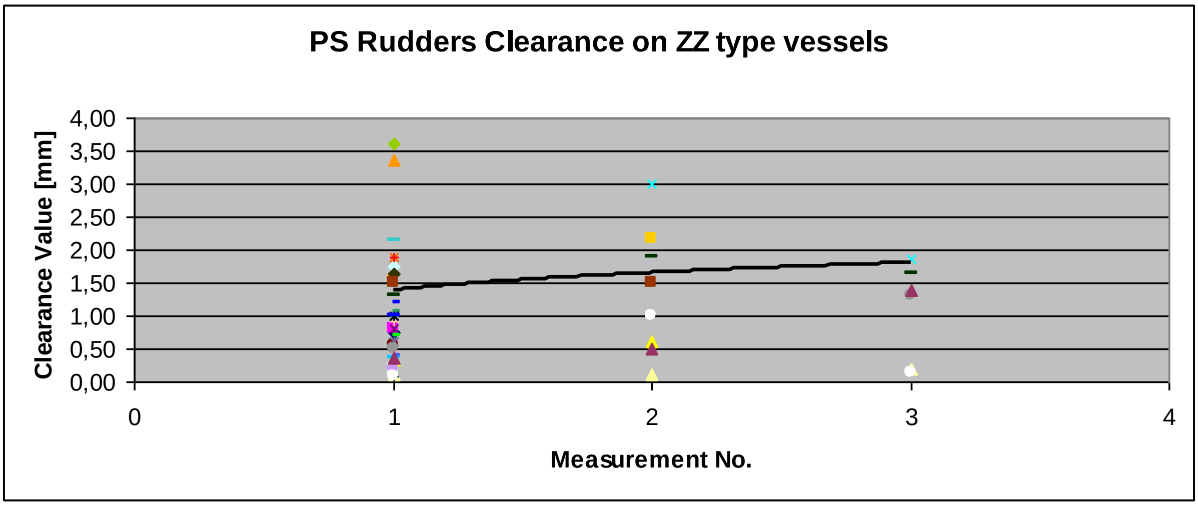

Figure 19

5.2.7 General cargo ships

5 of 600 measurements; 0.83% cases

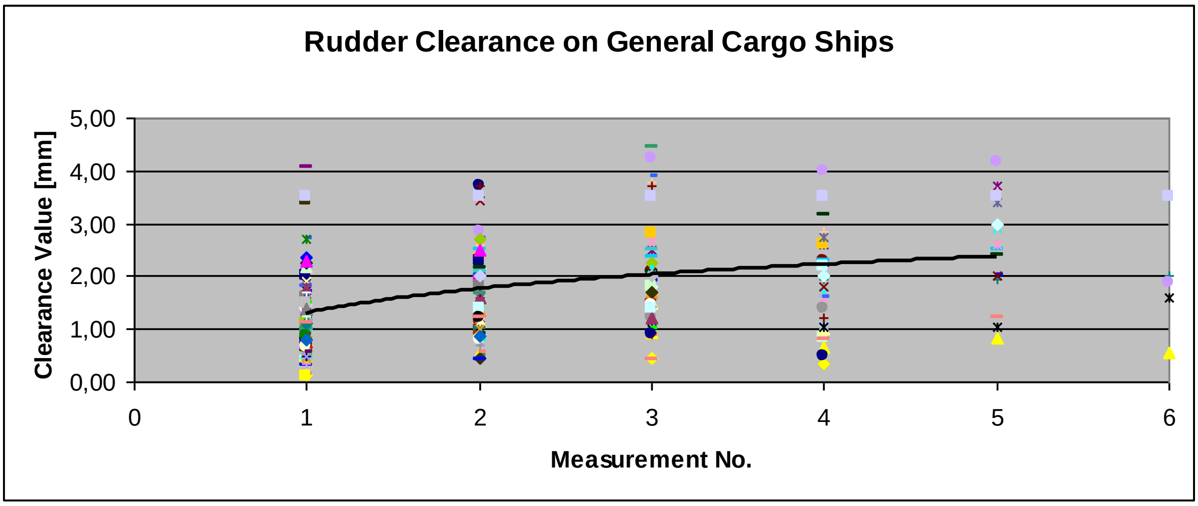

Figure 20

5.2.8 LNG and LPG ships

5 of 420 measurements; 1.1% cases

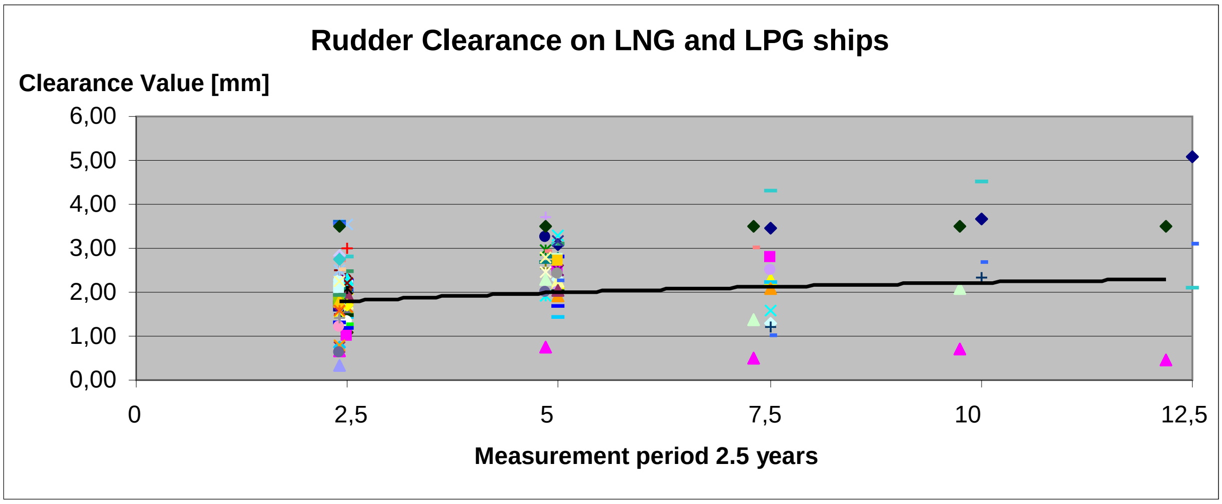

Figure 21

5.2.9 Containerships

10 of 580 measurements; 1.72% cases

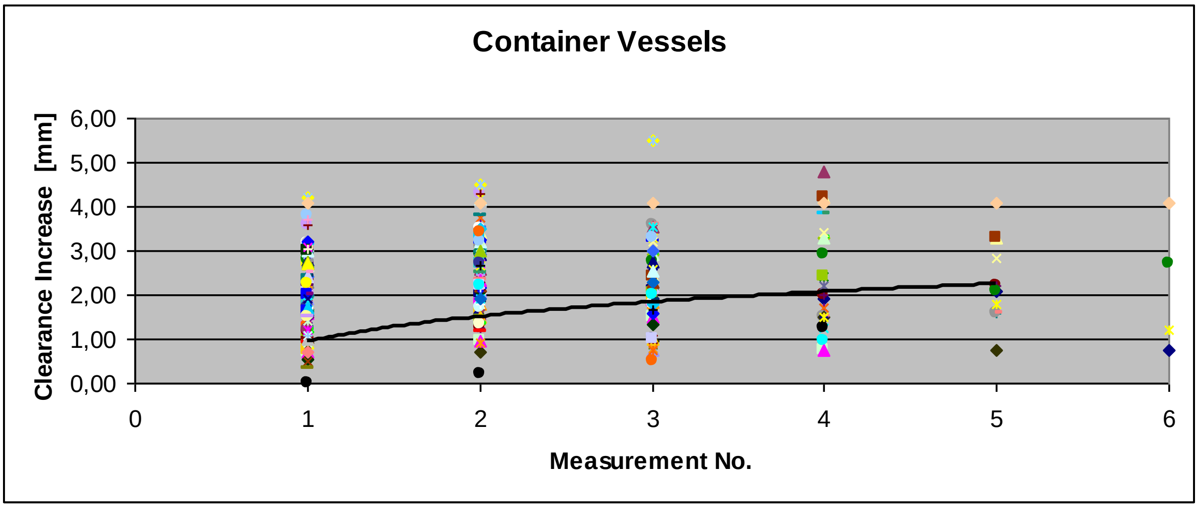

Figure 22

6 Conclusions

Type of vessel	Passenger Ships	Bulk Carriers	Oil Tankers	ZZ type	General cargo	LNG /LPG	Container Ships	Chemical Tankers
Total number of analysed clearance measurements	**580**	**1300**	**2000**	**300**	**600**	**420**	**580**	**200**
Clearance increase (in 5 years on dry-dock) [mm]	**0.76-0.81**	**0.63**	**0.75**	**0.75-0.76**	**0.78**	**0.72**	**0.76**	**0.67**
Clearance increase calculated during both DS and IWS [mm]	**0.0012**	**0.001**	**0.0002**	**-0.002**	**-0.0006**	**0.0005**	**0.001**	**-0.004**
Percentage of cases where rudder clearance is out of limit	**1.8%**	**0.53%**	**0.35%**	**0.6%**	**0.83%**	**1.1%**	**1.72%**	**0.5%**

Table 4

6.1 The clearance progression between two consecutive bottom inspections, spaced at a maximum of five years, in dry-dock, for all types of vessel, is very slow;

6.2 The highest increase of rudder clearance for a **five-year period, in dry-dock only,** is **0.81 mm;**

6.3 The most strict rule, (in terms of clearance increase), is **1.8 mm** of clearance increase;

6.4 Figures 2 to 11 show, for different types of ships, in general, that rudder clearance increase between consecutive measurements is of a limited amount.

6.5 Figures 13 to 22 show, for different types of ships, in general, a limited number of cases where the rudder clearance exceeded the allowable limit.

6.6 The results from section 3, show that taking into account only the measurements of rudder clearance taken afloat (IWS) gives an inaccurate picture of the rudder bearing condition.

6.7 Taking into account the above data, it can be stated that there are no differences among the various types of ships, with regard to rudder clearance propagation. It can be suggested that further consideration regarding the requirement of clearance measurement during IWS should be undertaken.

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