Bollard Pull Certification Procedures – Guidance Information, 1992

1. Introduction

1.1 Whilst full scale bollard pull certification is neither a statutory or classification requirement, a true figure of the bollard pull capability is often required. This may be particularly important should the vessel Owner’s liability be raised in case of damage to a towed object or inability to achieve and/or maintain a minimum speed needed to ensure satisfactory steerage in adverse conditions.

This procedure is primarily intended for tugs supply vessels and other vessels of similar type, generally referred to in the document on ‘tug’. However, consideration will be given to its application to other vessel types on an individual basis.

The purpose of these notes concerning certification is to standardise the procedure as far as is possible in order to ensure that results of bollard pull testing performed at different locations yield comparable results.

1.2 At the request of the Owners and/or Shipbuilders, the Surveyors may witness and certify bollard pull performance testing. Such testing should normally be undertaken at an installation which affords sufficient ‘sea’ room and which is equipped appropriately with suitable anchorage point and calibrated equipment.

In all cases the presence of the Surveyor will be necessary throughout the testing programme.

The Certificate to be issued after the tests will normally take the form of a factual statement on a Report form, a typical example of which is included for guidance purposes at Appendix A.

1.3 For geographic areas where properly equipped installations do not exist and therefore standard bollard pull testing is not possible, consideration will be given to the bollard pull certification using anchors of sufficient holding power as the anchorage point.

1.4 In exceptional cases when neither method of bollard pull testing described in para 1.2 - 1.3 is possible, the Society may at the specific request of the Shipyard or Owner, consider certification of bollard pull based on model testing and theoretical prediction analysis. However, in such a case the final Certificate will be headed “Certificate of Calculated Bollard Pull”.

2. Data to be Submitted

2.1 Prior to actual testing the Shipyard/Owner should provide the following information:-
   - Location of tests,
   - Detailed plan of bollard pull test configuration,
   - Specification of measuring equipment to be used, i.e, Instrumentation type, number and location of load cells,
   - Recording procedure.

2.2 In addition the following plans and information will be required:-
   - Main particulars and dimensions of the tug,
   - Block coefficient at load draught,
   - Load draught,
   - Draft and trim for bollard pull test condition(s),
   - Type of main engine(s),
   - Max continuous rating and rpm,
   - Continuous service rating and rpm,
   - Gearing ratio,
   - Propeller type and diameter, number of blades and pitch,
   - Type of propeller duct where applicable,
   - Open water service speed,
   - Anticipated maximum bollard pull.

3. Bollard Pull Definitions

3.1 The following definitions have been made for the purposes of the procedure:-
   a) **The Maximum Bollard Pull (MBP)** - is equal to the maximum average of recorded tension in the towing wire over a period of one minute during testing at an approved installation. MBP is normally associated with the maximum engine output and optimum propeller pitch.
   
   b) **The Steady Bollard Pull (SBP)** - this bollard pull should be achievable over a period of not less than 5 minutes. It represents the continuously maintained tension in the towing wire.

   Where peculiarities of a particular testing site are such that sustained 5 minute pull is difficult to achieve, bollard pull readings could be made at the times when the tug’s pull and direction are steady.

   c) **The Effective Bollard Pull (EBP)** - is the bollard pull which a tug can develop in an open seaway. EBP is not normally established during testing at approved establishments and in most cases represents a fraction of the SBP. This fraction is often taken to be about 0.75 x SBP after making due allowance for weather.

4. Test Procedure

Bollard pull tests should be carried out under similar conditions to facilitate comparison with results obtained at different testing establishments. These conditions are:-
4.1 Testing environment:-

Testing should be carried out in a location that provides a sufficient extent of deep open water and a shore anchorage point of adequate strength.

For general guidance the following should be noted:-

Clear open water, is defined as:-

- Open water between the stern and the shore line of not less than twice the tug’s length.
- Open water to each side of the tug for a distance equal to the tug’s length.
- Open water ahead of the tug for an adequately safe distance.

Depth of water under the keel should be equal to twice the draught, with a minimum of 10 metres.

Current speed at the test location should not exceed 0.5 m/sec in any direction.

Wind speed should be such that the performance of the tug is not materially affected. For guidance purposes it is suggested a maximum wind speed of 5 m/sec is adopted.

Sea condition should be calm i.e, with no swell or other significant waves.

4.2 Condition of tug:-

The tug’s displacement at the time of bollard pull testing will be recorded and an appropriate note will be made to that effect on the bollard pull certificate. Similarly all draughts will be stated. The trim of the tug before testing should, in principle, comply with the intended operating trim.

All deck equipment and fittings such as the towing winch and drum, towing hooks and strongbacks, fairleads etc., must be in good condition and capable of exerting/withstanding a load of not less than two times the anticipated Maximum Bollard Pull.

It is assumed that all equipment will be part of the tug’s normal outfit. Similarly, the propellers fitted when performing the tests should be those used during normal service.

4.3 Shaft Horsepower and RPM Recordings:-

At the initial phase of the bollard pull test the main engines of the tug will be set at dead slow or slow thus maintaining a minimal tension in the towing wire. During this phase the tug should be brought into position for the bollard pull trials proper.

The engine revolutions should be increased until fairly steady bollard pull readings are reached with the main engines at maximum continuous power.

The five minute interval referred to in para 3 (b) should be selected at the peak portion of the bollard pull curve. During bollard pull testing, difficulties may be experienced in maintaining the tug in a desired position particularly if the tug has an excessive tendency to yaw. In such a situation rudder action may be necessary. In general, the application of the rudder will tend to adversely effect the recording.

Shaft revolutions, torsionmeter readings and all other relevant engine data coupled with recordings of the rudder angle indicator and the angle of yaw during the trial should be synchronised with the readings of bollard pull.

If bollard pull is determined from a main engine overload condition, an appropriate statement will be made on the certificate. Similarly, if any auxiliary machinery normally driven from the main engine is disconnected during testing, a suitable note should also be made on the certificate.

In all cases, for the purpose of certification, the testing programme should include a run with the main engine developing its maximum continuous power.

5. Instrumentation

The dynamometer used during testing should produce continuous readout in numerical and graphical form. The instrument should be calibrated before each application by the Society or any other recognised authority. The combined accuracy and linearity of the calibrated mechanical load gauge or electrical load cell and the associated readout instrumentation is expected to be within ± 2% of the anticipated steady bollard pull.

It is anticipated that propeller shaft power will be measured to an accuracy of ± 3% of the maximum continuously rated engine output.

The dynamometer should be incorporated within the towing wire system and could, in principle, be located at the shore line or on the tug where there is sufficient space available on deck.

The recordings of the dynamometer should be coupled with the recordings of the main engine output and shaft revolutions (see also paragraph 4.3)

The dynamometer could be of the form of mechanical load gauge or an electric load cell. Background guidance concerning the method of measurement using this instrumentation is given in Appendix B.
Whilst the accuracy of the bollard pull measurements necessarily depends on the reliability and cumulative performance of all instruments utilised in the measurement process, it is anticipated that the accuracy of the certified bollard pull at the stated machinery output will be contained within ± 4\% of the true value.

6. Certification

On completion of the bollard pull testing a full report should be prepared by the Society’s Technical Investigations (TIPEE) Department or other authorised Agency responsible for carrying out the test. This report should contain all the relevant information concerning the tug, environmental data, propeller, machinery, instrumentation and all trial records.

From the recorded curve of bollard pull, a steady bollard pull (SBP) will be established over any selected period lasting not less than 5 minutes. This value should in fact be the mean of the recordings achieved during that period. The maximum bollard pull (MBP) should correspond to the maximum recorded pull during the above period.

If the above values are also obtained for the engine overload conditions, these should also be recorded.

For the purpose of formal certification a Report will be issued to the builder or owner as per enclosed specimen.

It is intended that all tug and supply vessels for which bollard pull certification is required will have the Steady Bollard Pull value entered into column 7 of the Register Book as reliable information on the towing capability.

Where it is specially requested, bollard pull may be certified for more than one engine setting. This certification may cover a range of bollard pulls from idling to full speed and may be of interest for tugs engaged in regular harbour service.

Appendix A

A.1 Certificate of Bollard Pull

A.1.1 For guidance purposes a sample “Bollard Pull Certificate” is appended.

Tab A.1(a) - Certificate of Bollard Pull

<table>
<thead>
<tr>
<th>Ship's name</th>
<th>Certificate No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>Office</td>
</tr>
<tr>
<td>Shipbuilder</td>
<td>Date</td>
</tr>
<tr>
<td>Location bollard pull trials held</td>
<td>Yard No.</td>
</tr>
</tbody>
</table>

This certificate is issued to

to certify that the undersigned Surveyors to Lloyd’s Register attended the bollard pull trials stated above for the purpose of ascertaining the bollard pull capacity of the subject ship, at the request of:

The relevant particulars of the ship and its machinery and propellers together with the significant trials data are listed on the reverse of this certificate. The trials were completed and the following results were obtained:

**TRIAL RESULTS**

<table>
<thead>
<tr>
<th>Run No.</th>
<th>Start Time</th>
<th>End Time</th>
<th>Shaft RPM</th>
<th>Shaft HP</th>
<th>SBP</th>
<th>MBP</th>
</tr>
</thead>
<tbody>
<tr>
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**CERTIFIED BOLLARD PULL**

It is hereby certified that the vessel under the conditions described overleaf, exerted a Steady Bollard Pull (SBP) over a minimum of 5 minutes duration of . . . . . . . . . . . . . tonnes force.

It is also certified that the Maximum Bollard Pull (MBP) during the same five minute interval was . . . . . . . . . . . . . tonnes force.

These results were recorded, during run number . . . . . . . . without the main engine being overloaded.

Shaft driven auxiliaries were fully engaged / not engaged / not fitted (delete as applicable)
Bollard Pull Certification Procedures – Guidance Information, 1992

NOTICE - This certificate is subject to the terms and conditions overleaf, which form part of this certificate

Tab A.1(b) -

**SHIP PARTICULARS**

<table>
<thead>
<tr>
<th>Length B.P. (m)</th>
<th>Moulded Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moulded Breadth (m)</td>
<td>Design Draught (m)</td>
</tr>
</tbody>
</table>

**MACHINERY PARTICULARS**

<table>
<thead>
<tr>
<th>Engine Builders</th>
<th>Propeller Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Type</td>
<td>Propeller Plan Number</td>
</tr>
<tr>
<td>Engine Number</td>
<td>Number Fitted</td>
</tr>
<tr>
<td>Shaft Driven Auxiliaries (HP)</td>
<td>Fixed/CPP</td>
</tr>
<tr>
<td>Gear Ratio</td>
<td>Propeller Diameter</td>
</tr>
<tr>
<td>Number of Blades</td>
<td></td>
</tr>
<tr>
<td>Number Fitted</td>
<td></td>
</tr>
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<td>Shaft Driven Auxiliaries (HP)</td>
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<td>Gear Ratio</td>
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<tr>
<td>Propeller Diameter</td>
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<tr>
<td>Number of Blades</td>
<td></td>
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<tr>
<td>Propeller RPM</td>
<td></td>
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<tr>
<td>Propeller Duct Type</td>
<td></td>
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</tbody>
</table>

**TRIAL PARTICULARS**

<table>
<thead>
<tr>
<th>Draught Forward (m)</th>
<th>Water Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draught Aft (m)</td>
<td>Temperature of Water (°C)</td>
</tr>
<tr>
<td>Mean Draught (m)</td>
<td>Density of Water (t/m³)</td>
</tr>
<tr>
<td>Trim (m)</td>
<td>Wind Speed (m/s)</td>
</tr>
<tr>
<td>Displacement (t)</td>
<td>Current Speed (m/s)</td>
</tr>
<tr>
<td>Immersion of Propeller Tips (% diameter)</td>
<td>Observed Wave Height (m)</td>
</tr>
<tr>
<td>Distance from Stern of Ship to Pier (m)</td>
<td>Height of Towing Hook above Water Level (m)</td>
</tr>
<tr>
<td>Type of Load Cell</td>
<td>Height of Bollard above Water Level (m)</td>
</tr>
<tr>
<td>Date of Calibration</td>
<td>Angle of Hawser from Horizontal Plane (deg)</td>
</tr>
</tbody>
</table>

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**Appendix B**

**B.1 Measurements Guidance Notes**

**B.1.1** Either a mechanical load gauge or an electric load cell is usually suitable for bollard pull measurement purposes. If the load gauge is of one of the types designed for weighing crane loads, care should be taken to verify that the particular type of instrument is suitable for use in a horizontal position. The electric load cell has the advantage that it may
readily be connected to a suitable autographic recorder to give a continuous record of the pull. The gauge should be calibrated, preferably both before and after the trial, and it is advisable that the calibration should be carried out with the gauge in the horizontal position in which it is used.

B.1.2 The arrangement should be such that the pull is taken on the tug's towing hook, or towing cable and the gauge may be inserted in the cable either adjacent to the towing hook or where it is anchored to the bollard ashore. The arrangement with the load gauge adjacent to the towing hook offers the advantage that the entire trials party can be stationed on the tug, but it has the disadvantage that the readings may be influenced by the friction of the cable on the towing horse and there may be practical difficulties in supporting the gauge so as to prevent it being damaged when the tension comes off the cable. With the gauge ashore, provision should be made to allow it to swing freely about the bollard so as to align itself with the cable as the tug sheers from side to side and to ensure that only the horizontal component of the pull is measured. A satisfactory arrangement is one in which the gauge is mounted on a special trolley running on a steel plate laid upon the quay. Alternatively, the gauge may be allowed to skid on greased plates or planks. The body of the gauge should be the anchored part and care should be taken to ensure that the cable runs clear from the gauge to the tug without fouling the coping of the quay wall or other obstruction.

B.1.3 If the bollard pull is recorded continuously throughout a test, the record might be expected to show the principle features of the curve given at the end of this appendix. That is, the general level of the pull readings would show an initial rise while the engine revolutions are building up, followed by a period during which the readings are fairly steady, and finally the pull might start to fall as a result of induced circulation of the water. Superimposed on this characteristic trend, various oscillations will normally be noted, typically a cyclic variation with a period of about 10 or 20 seconds, which appears to be related to the rudder movements required to keep the tug in position, and a higher frequency oscillation with a period of one or two seconds, which probably represents the natural period of oscillation of the tug on the cable.

B.1.4 The extent to which these oscillations are recorded depends upon the frequency with which the gauge is read and the mechanical characteristics of the particular gauge used. For this reason the average pull sustained for a minimum of five minutes should be taken. In the absence of an auto-graphic recorder, the load gauge should be monitored continuously and the maximum and minimum readings observed in each 30 second interval should be recorded.

The above curve is purely schematic and does not refer to any particular case.

Curve of Bollard Pull Readings Against Time