

Z21 Surveys of Propeller Shafts and Tube Shafts

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Note:

1. Ex-UR M20.2 “Surveys of propeller Shafts and Tube Shafts” was re-categorized as UR Z21 in November 2001.
2. Changes introduced in Rev.1 are to be uniformly implemented from 1 July 2007.
3. Changes introduced in Rev. 2 are to be uniformly implemented from 1 Jan 2008.
4. Rev.3 is to be uniformly implemented as follow:
 - 4.1 from 1 January 2016 for ships delivered on or after 1 January 2016;
 - 4.2 after the first shaft survey scheduled on or after 1 January 2016, for ships delivered before 1 January 2016.

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1. General

1.1 Application

1.1.1 Unless alternative means are provided to assure the condition of the propeller shaft assembly, these requirements apply to all vessels with conventional shafting fitted with a propeller as follows:

1.1.1.1 from 1 January 2016 for ships delivered on or after 1 January 2016;

1.1.1.2 after the first shaft survey scheduled on or after 1 January 2016, for ships delivered before 1 January 2016*.

*Upon the completion of the first shaft survey scheduled on or after 1 January 2016, the designation of dates for the next shaft survey is to be made based upon Rev.3 of this UR.

1.2 Definitions

See also Diagram 1.

1.2.1 Shaft

For the purpose of this Unified Requirement shaft is a general definition that could mean:

- Propeller shaft

- Tube shaft

The definition does not include the intermediate shaft(s) which is(are) considered part of the propulsion shafting inside the vessel.

1.2.2 Propeller Shaft

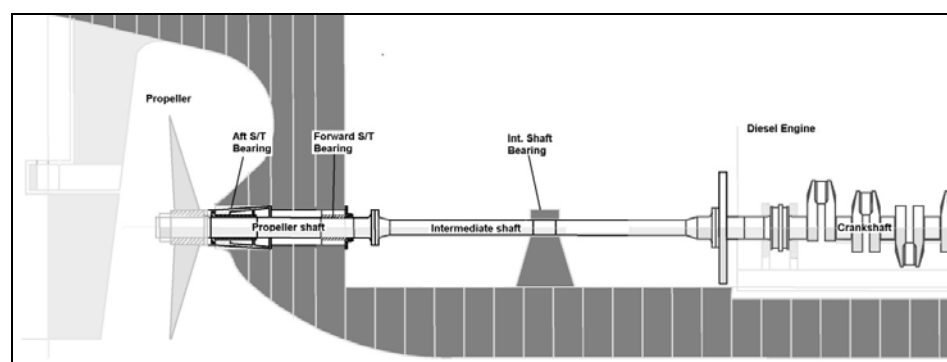
Propeller shaft is the part of the propulsion shaft to which the propeller is fitted. It may also be called screwshaft or tailshaft.

1.2.3 Tube Shaft

Tube shaft is a shaft placed between the intermediate shaft and propeller shaft, normally arranged within a stern tube or running in open water.

It may also be called **Stern Tube Shaft**.

Diagram 1: Typical Shafting Arrangement



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1.2.4 Sterntube

Tube or pipe fitted in the shell of a ship at the stern (or rear part of the ship), below the water-line, through which passes the tube shaft or aftermost section of the propeller-shaft.

Sterntube is the housing of the shaft bearings, generally two (one aft and one fore), that sustain the shaft and allows its rotation with less frictional resistance. The stern tube also accommodates the shaft sealing arrangement.

1.2.5 Close Loop (system) Oil Lubricated bearing

Closed loop oil lubricating systems use oil to lubricate the bearings and are sealed against the environment (seawater) by adequate sealing / gland devices.

1.2.6 Water Lubricated Bearing

Water lubricated bearings are bearings cooled / lubricated by water (fresh or salt).

1.2.7 Closed Loop System Fresh Water Lubricated Bearing

Closed loop water lubricating systems use fresh water to lubricate the bearings and are sealed against the environment (such as seawater) by adequate sealing / gland devices.

1.2.8 Open Systems (water)

Open water lubricating systems use water to lubricate the bearings and are exposed to the environment.

1.2.9 Adequate means for protection against corrosion

An adequate means for protection against corrosion is an approved means for full protection of the core shaft against sea water intrusion and subsequent corrosion attack. Such means are used for the protection of common steel material against corrosion particularly in combination with water lubricated bearings.

Typical means are for example:

- continuous metallic, corrosion resistant liners,
- continuous cladding,
- multiple layer synthetic coating,
- multiple layer of fiberglass,
- combinations of above mentioned,
- rubber / elastomer covering coating.

The means for protection against corrosion are installed / applied according to class approved procedures.

1.2.10 Corrosion Resistant Shaft

Corrosion resistant shaft is made in approved corrosion resistant steel as core material for the shaft.

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(cont)**1.2.11 Sterntube Sealing System**

Sterntube Sealing system is the equipment installed on the inboard extremity and, for closed systems, at outboard extremity of the sterntube.

Inboard Seal is the device fitted on the fore part of the sterntube that achieve the sealing against the possible leakage of the lubricant media in to the ship internal.

Outboard seal is the device fitted on the aft part of the sterntube that achieve the sealing against the possible sea water ingress and the leakage of the lubricant media.

1.2.12 Service records

Service records are regularly recorded data showing in-service conditions of the shaft(s) and may include, as applicable: lubricating oil temperature, bearing temperature and oil consumption records (for oil lubricated bearings) or water flow, water temperature, salinity, pH, make-up water and water pressure (for closed loop fresh water lubricated bearings depending on design).

1.2.13 Oil sample examination

An oil sample examination is a visual examination of the stern tube lubricating oil taken in presence of the surveyor with a focus on water contamination.

1.2.14 Lubricating oil analysis

Lubricating oil analysis is to be carried out at regular intervals not exceeding six (6) months taking into account IACS Rec. 36.

The documentation on lubricating oil analysis is to be available on board.
Oil samples, to be submitted for the analysis, should be taken under service conditions.

1.2.15 Fresh Water sample test

Fresh water sample test should be carried out at regular intervals not exceeding six (6) months

Samples are to be taken under service conditions and are to be representative of the water circulating within the sterntube.

Analysis results are to be retained on board and made available to the surveyor.

At time of survey the sample for the test has to be taken at the presence of the surveyor.

Fresh water sample test shall include the following parameters:

- chlorides content,
- pH value,
- presence of bearing particles or other particles (only for laboratory analysis, not required for tests carried out in presence of the surveyor).

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1.2.16 Keyless connection

Keyless connection is the forced coupling Methodology between the shaft and the propeller without a key achieved through interference fit of the propeller boss on the shaft tapered end.

1.2.17 Keyed connection

Keyed connection is the forced coupling Methodology between the shaft and the propeller with a key and keyway achieved through the interference fit of the propeller boss on the shaft tapered end.

1.2.18 Flanged connection

Flanged connection is the coupling Methodology, between the shaft and the propeller, achieved by a flange, built in at the shaft aft end, bolted to propeller boss.

1.2.19 Alternative means

"Alternative Means: are shafting arrangements with configuration other than described in the present document."

2. Oil Lubricated shafts or Closed Loop System Fresh Water Lubricated Shafts (closed system)

2.1 Shaft Survey Methods

2.1.1 METHOD 1

The survey is to consist of:

- Drawing the shaft and examining the entire shaft, seals system and bearings
- For keyed and keyless connections:
 - Removing the propeller to expose the forward end of the taper.
 - Performing a non-destructive examination (NDE) by an approved surface crack-detection method all around the shaft in way of the forward portion of the taper section, including the keyway (if fitted). For shaft provided with liners the NDE shall extended to the after edge of the liner.
- For flanged connection:
 - Whenever the coupling bolts of any type of flange-connected shaft are removed or the flange radius is made accessible in connection with overhaul, repairs or when deemed necessary by the surveyor, the coupling bolts and flange radius are to be examined by means of an approved surface crack detection method.
- Checking and recording the bearing clearances.
- Verification that the propeller is free of damages which may cause the propeller to be out of balance.
- Verification of the satisfactory conditions of inboard and outboard seals during the re-installation of the shaft and propeller.

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- Recording the bearing wear down measurements (after re-installation)

2.1.2 METHOD 2

The survey is to consist of:

- For keyed and keyless connections:
 - Removing the propeller to expose the forward end of the taper,
 - Performing a non-destructive examination (NDE) by an approved surface crack-detection Method all around the shaft in way of the forward portion of the taper section, including the keyway (if fitted).
- For flanged connection:
 - Whenever the coupling bolts of any type of flange-connected shaft are removed or the flange radius is made accessible in connection with overhaul, repairs or when deemed necessary by the surveyor, the coupling bolts and flange radius are to be examined by means of a an approved surface crack detection Method.
- Checking and recording the bearing wear down measurements.
- Visual Inspection of all accessible parts of the shafting system.
- Verification that the propeller is free of damages which may cause the propeller to be out of balance.
- Seal liner found to be or placed in a satisfactory condition.
- Verification of the satisfactory re-installation of the propeller including verification of satisfactory conditions of inboard and outboard seals.

Pre-requisites to satisfactorily verify in order to apply METHOD 2:

- Review of service records.
- Review of test records of:
 - Lubricating Oil analysis (for oil lubricated shafts), or
 - Fresh Water Sample test (for closed system fresh water lubricated shafts).
- Oil sample Examination (for oil lubricated shafts), or Fresh Water Sample test (for closed system fresh water lubricated).
- Verification of no reported repairs by grinding or welding of shaft and/or propeller.

2.1.3 METHOD 3

The survey is to consist of:

- Checking and recording the bearing wear down measurements.
- Visual Inspection of all accessible parts of the shafting system.

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- Verification that the propeller is free of damages which may cause the propeller to be out of balance.
- Seal liner found to be or placed in a satisfactory condition.
- Verification of the satisfactory conditions of inboard and outboard seals.

Pre-requisites to satisfactorily verify in order to apply METHOD 3:

- Review of service records.
- Review of test records of
 - Lubricating Oil analysis (for oil lubricated shafts), or
 - Fresh Water Sample test (for closed system fresh water lubricated shafts).
- Oil sample Examination (for oil lubricated shafts), or Fresh Water Sample test (for closed system fresh water lubricated).
- Verification of no reported repairs by grinding or welding of shaft and/or propeller.

2.2 Shaft extension surveys - Extension types

2.2.1 Extension up to 2,5 years

The survey is to consist of:

- Checking and recording the bearing wear down measurements, as far as practicable.
- Visual Inspection of all accessible parts of the shafting system.
- Verification that the propeller is free of damages which may cause the propeller to be out of balance.
- Verification of the effectiveness of the inboard seal and outboard seals.

Pre-requisites to satisfactorily verify in order to apply EXTENSION UP TO 2,5 YEARS:

- Review of service records.
- Review of test records of
 - Lubricating Oil analysis (for oil lubricated shafts), or
 - Fresh Water Sample test (for closed system fresh water lubricated shafts).
- Oil sample Examination (for oil lubricated shafts), or Fresh Water Sample test (for closed system fresh water lubricated).
- Verification of no reported repairs by grinding or welding of shaft and/or propeller.
- Confirmation from the Chief Engineer that the shafting arrangement is in good working condition.

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2.2.2 Extension up to 1 year

The survey is to consist of:

- Visual Inspection of all accessible parts of the shafting system.
- Verification that the propeller is free of damages which may cause the propeller to be out of balance.
- Verification of the effectiveness of the inboard seal and outboard seals.

Pre-requisites to satisfactorily verify in order to apply EXTENSION UP TO 1YEAR:

- Review of the previous wear-down and/or clearance recordings.
- Review of service records.
- Review of test records of
 - Lubricating Oil analysis (for oil lubricated shafts), or
 - Fresh Water Sample test (for closed system fresh water lubricated shafts).
- Oil sample Examination (for oil lubricated shafts), or Fresh Water Sample test (for closed system fresh water lubricated).
- Verification of no reported repairs by grinding or welding of shaft and/or propeller.
- Confirmation from the Chief Engineer that the shafting arrangement is in good working condition.

2.2.3 Extension up to 3 months

The survey is to consist of:

- Visual Inspection of all accessible parts of the shafting system.
- Verification of the effectiveness of the inboard seal.

Pre-requisites to satisfactorily verify in order to apply EXTENSION UP TO 3 MONTHS:

- Review of the previous wear-down and/or clearance recordings.
- Review of service records.
- Review of test records of.
 - Lubricating Oil analysis (for oil lubricated shafts), or
 - Fresh Water Sample test (for closed system fresh water lubricated shafts).
- Oil sample Examination (for oil lubricated shafts), or Fresh Water Sample test (for closed system fresh water lubricated).
- Verification of no reported repairs by grinding or welding of shaft and/or propeller.

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- : Confirmation from the Chief Engineer that the shafting arrangement is in good working condition.

2.3 Oil lubricated shafts**2.3.1 Survey intervals**

For surveys completed within 3 months before the shaft survey due date, the next period will start from the shaft survey due date.

2.3.1.1 Flanged propeller connection

The following Methods are applicable:

- A) Method 1 every 5 years, or
- B) Method 2 every 5 years (pre-requisites have to be fulfilled), or
- C) Method 3 every 5 years (pre-requisites have to be fulfilled).

2.3.1.2 Keyless propeller connection

The following Methods are applicable:

- A) Method 1 every 5 years, or
- B) Method 2 every 5 years (pre-requisites have to be fulfilled), or
- C) Method 3 every 5 years with the maximum of two consecutive Method 3 surveys (pre-requisites have to be fulfilled). The maximum interval between two surveys carried out according to Method 1 or Method 2 shall not exceed 15 years, except in the case when one extension for no more than three months is granted.

2.3.1.3 Keyed propeller connection

The following Methods are applicable:

- A) Method 1 every 5 years, or
- B) Method 2 every 5 years (pre-requisites have to be fulfilled).

2.3.2 Survey extensions

For all types of propeller connections, the interval between two consecutive surveys may be extended after the execution of extension survey as follows:

- A) **Extension up to a maximum of 2.5 years:** no more than one extension can be granted. No further extension, of other type, can be granted.
- B) **Extension up to a maximum of 1 year:** no more than two consecutive "one year extensions" can be granted. No further extension, of other type, can be granted.

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- C) **Extension up to a maximum of 3 months:** no more than one “three months extension” can be granted. In the event an additional extension is requested the requirements of the “one year extension” are to be carried out and the shaft survey due date, prior to the previous extension, is extended for a maximum of one year.

The extension survey should normally be carried out within 1 month of the shaft survey due date and the extension counts from the shaft survey due date.

If the extension survey is carried out more than 1 month prior to the shaft survey due date, then the period of extension counts from the date of the extension survey was completed.

2.4 Closed loop system fresh water lubricated shafts

The maximum interval between two surveys carried out according to Method 1 shall not exceed 15 years. An extension for no more than three months can be granted.

2.4.1 Survey intervals

For surveys completed within 3 months before the shaft survey due date, the next period will start from the shaft survey due date.

2.4.1.1 Flanged propeller connection

The following Methods are applicable:

- A) Method 1 every 5 years, or
- B) Method 2 every 5 years (pre-requisites have to be fulfilled), or
- C) Method 3 every 5 years (pre-requisites have to be fulfilled).

2.4.1.2 Keyless propeller connection

The following Methods are applicable:

- A) Method 1 every 5 years, or
- B) Method 2 every 5 years (pre-requisites have to be fulfilled), or
- C) Method 3 every 5 years (pre-requisites have to be fulfilled).

2.4.1.3 Keyed propeller connection

The following Methods are applicable:

- A) Method 1 every 5 years, or
- B) Method 2 every 5 years (pre-requisites have to be fulfilled).

2.4.2 Survey extensions

For all types of propeller connections, the interval between two consecutive surveys may be extended after the execution of extension survey as follows:

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- A) Extension up to a maximum of 2,5 years, no more than one extension can be granted. No further extension, of other type, can be granted.
- B) Extension up to a maximum of 1 year, no more than two consecutive extensions can be granted. No further extension, of other type, can be granted.
- C) Extension up to a maximum of 3 months, no more than one “three months extension” can be granted. In the event an additional extension is requested the requirements of the “one year extension” are to be carried out and the shaft survey due date prior to the previous extension is extended for a maximum of one year.

The extension survey should normally be carried out within 1 month of the shaft survey due date and the extension counts from the shaft survey due date.

If the extension survey is carried out more than 1 month prior to the shaft survey due date, then the period of extension counts from the date of the extension survey was completed.

The maximum interval between two surveys carried out according to Method 1 shall not exceed 15 years, except in the case when one extension for no more than three months is granted.

2.5 TABLE of Survey Intervals (closed systems)

SURVEY INTERVALS (closed systems)			
Oil Lubricated			
	<u>Flanged Propeller Coupling</u>	<u>Keyless Propeller Coupling</u>	<u>Keyed Propeller Coupling^c</u>
<u>Every five years^a</u>	<u>Method1 or Method 2 or Method 3</u>	<u>Method1 or Method 2 or Method 3^d</u>	<u>Method1 or Method 2</u>
<u>Extension 2,5 Y^b</u>	<u>Yes^e</u>	<u>Yes^e</u>	<u>Yes^e</u>
<u>Extension 1 Y^b</u>	<u>Yes^f</u>	<u>Yes^f</u>	<u>Yes^f</u>
<u>Extension 3 M^d</u>	<u>Yes^g</u>	<u>Yes^g</u>	<u>Yes^g</u>
Closed Loop System Fresh Water Lubricated			
	<u>Flanged Propeller Coupling</u>	<u>Keyless Propeller Coupling</u>	<u>Keyed Propeller Coupling^c</u>
<u>Every five years^a</u>	<u>Method1^h or Method 2 or Method 3</u>	<u>Method1^h or Method 2 or Method 3</u>	<u>Method1^h or Method 2</u>
<u>Extension 2,5 Y^b</u>	<u>Yes^e</u>	<u>Yes^e</u>	<u>Yes^e</u>
<u>Extension 1 Y^d</u>	<u>Yes^f</u>	<u>Yes^f</u>	<u>Yes^f</u>
<u>Extension 3 M^d</u>	<u>Yes^g</u>	<u>Yes^g</u>	<u>Yes^g</u>
General notes:			
<u>For surveys (Method 1, or Method 2, or Method 3) completed within 3 months before the shaft survey due date, the next period will start from the shaft survey due date.</u>			
<u>The extension survey should normally be carried out within 1 month of the shaft survey due date and the extension counts from the shaft survey due date. If the extension survey is carried out more than 1 month prior to the shaft survey due date, then the period of extension counts from the date of the extension survey was completed.</u>			
Notes:			
<u>a: unless an Extension type (Extension 2,5 Y, Extension 1 Y, Extension 3 M) is applied in between.</u>			
<u>b: only one Extension type can be applied in between of two Methods (Extension 2,5 Y, or Extension 1 Y) except for what concern the Extension 3 M (see further note g).</u>			
<u>c: Method 3 not allowed.</u>			
<u>d: maximum of two consecutives Method 3 surveys. The maximum interval between two surveys carried out according to Method 1 or Method 2 shall not exceed 15 years, except in the case when one extension for no more than three months is granted.</u>			
<u>e: no more than one extension can be granted. No further extension of other type can be granted.</u>			
<u>f: no more than two consecutive extensions can be granted. No further extension of other type can be granted.</u>			
<u>g: no more than one three months extension can be granted. In the event an additional extension is requested the requirements of the one year extension are to be carried out and the shaft survey due date prior to the previous extension is extended for a maximum of one year.</u>			
<u>h: The maximum interval between two surveys carried out according to Method 1 shall not be more than 15 years.</u>			

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3. Water Lubricated shafts (open systems)

3.1 Shaft Survey Methods

3.1.1 METHOD 4

The survey is to consist of:

- Drawing the shaft and examining the entire shaft (including liners, corrosion protection system and stress reducing features, where provided), inboard seal system and bearings.
- For keyed and keyless connections:
 - removing the propeller to expose the forward end of the taper,
 - performing a non-destructive examination (NDE) by an approved surface crack-detection Method all around the shaft in way of the forward portion of the taper section, including the keyway (if fitted). For shaft provided with liners the NDE shall be extended to the after edge of the liner
- For flanged connection:
 - Whenever the coupling bolts of any type of flange-connected shaft are removed or the flange radius is made accessible in connection with overhaul, repairs or when deemed necessary by the surveyor, the coupling bolts and flange radius are to be examined by means of an approved surface crack detection method.
- Checking and recording the bearing clearances.
- Verification that the propeller is free of damages which may cause the propeller to be out of balance.
- Verification of the satisfactory conditions of inboard seal during re-installation of the shaft and propeller.

3.2 Shaft extension surveys - Extension types

3.2.1 Extension up to 1 year

The survey is to consist of:

- Visual Inspection of all accessible parts of the shafting system.
- Verification that the propeller is free of damages which may cause the propeller to be out of balance.
- Checking and recording the clearances of bearing.
- Verification of the effectiveness of the inboard seal.

Pre-requisites to satisfactorily verify in order to apply EXTENSION UP TO 1YEAR:

- Review of the previous clearance recordings.

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- Service records.
- Verification of no reported repairs by grinding or welding of shaft and/or propeller.
- Confirmation from the Chief Engineer that the shafting arrangement is in good working condition.

3.2.2 Extension up to 3 months

The survey is to consist of:

- Visual Inspection of all accessible parts of the shafting system.
- Verification that the propeller is free of damages which may cause the propeller to be out of balance.
- Verification of the effectiveness of the inboard seal.

Pre-requisites to satisfactorily verify in order to apply EXTENSION UP TO 3 MONTHS:

- Review of the previous clearance recordings.
- Service records.
- Verification of no reported repairs by grinding or welding of shaft and/or propeller.
- Confirmation from the Chief Engineer that the shafting arrangement is in good working condition.

3.3 Shaft Survey Intervals**3.3.1 Survey Intervals**

The following survey intervals between surveys according to Method 4 are applicable to all types of propeller connections.

- For keyless propeller connections the maximum interval between two consecutive dismantling and verifications of the shaft cone by means of non-destructive examination (NDE) shall not exceed 15 years.
- For surveys completed within 3 months before the shaft survey due date, the next period will start from the shaft survey due date.

3.3.1.1 Configurations allowing 5 year intervals

- Single shaft operating exclusively in fresh water.
- Single shaft provided with adequate means of corrosion protection, single corrosion resistant shaft.
- All kinds of multiple shafts arrangements.

3.3.1.2 Other systems

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Shaft not belonging in one of the configurations listed in 3.3.1.1 has to be surveyed according to Method 4 every 3 years.

3.3.2 Survey extensions

For all types of propeller connections, the interval between two consecutive surveys may be extended after the execution of extension survey as follows:

- A) **Extension up to a maximum of 1 year:** no more than one extension can be granted. No further extension, of other type, can be granted.
- B) **Extension up to a maximum of 3 months:** no more than one “three months extension” can be granted. In the event an additional extension is requested the requirements of the “one year extension” are to be carried out and the shaft survey due date prior to the previous extension is extended for a maximum of one year.

The extension survey should normally be carried out within 1 month of the shaft survey due date and the extension counts from the shaft survey due date.

If the extension survey is carried out more than 1 month prior to the shaft survey due date, then the period of extension counts from the date of the extension survey was completed.

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3.4 TABLE of Survey Intervals (open systems)

<u>SURVEY INTERVALS (open systems)</u>			
<u>- Single Shaft operating exclusively in Fresh Water.</u> <u>- Single Shaft provided with adequate means of corrosion protection, Single corrosion resistant shaft.</u> <u>- All kinds of Multiple shafts arrangements.</u>		<u>Other shaft configuration.</u>	
<u>All kinds of Propeller Coupling^d</u>		<u>All kinds of Propeller Coupling^d</u>	
<u>Every five years^a</u>	<u>Method 4</u>	<u>Every three years^a</u>	<u>Method 4</u>
<u>Extension 1 Y</u>	<u>Yes^b</u>	<u>Extension 1 Y</u>	<u>Yes^b</u>
<u>Extension 3 M</u>	<u>Yes^c</u>	<u>Extension 3 M</u>	<u>Yes^c</u>
<p><u>General notes:</u> <u>For surveys (Method 4) completed within 3 months before the shaft survey due date, the next period will start from the shaft survey due date.</u> <u>The extension survey should normally be carried out within 1 month of the shaft survey due date and the extension counts from the shaft survey due date. If the extension survey is carried out more than 1 month prior to the shaft survey due date, then the period of extension counts from the date of the extension survey was completed.</u></p>			
<p><u>Notes:</u> <u>a: unless an Extension type (Extension 1 Y, Extension 3 M) is applied in between.</u> <u>b: no more than one extension can be granted. No further extension, of other type, can be granted.</u> <u>c: no more than one extension can be granted. In the event an additional extension is requested the requirements of the one year extension are to be carried out and the shaft survey due date prior to the previous extension is extended for a maximum of one year.</u> <u>d: For keyless propeller connections the maximum interval between two consecutive dismantling and verifications of the shaft cone by means of non-destructive examination (NDE) shall not exceed 15 years</u></p>			

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1. ~~Normal Survey~~

~~Propeller shafts and tube shafts are to be sufficiently drawn to permit entire examination at the following intervals unless alternative means are provided to assure the condition of the shaft:~~

~~A)(i) Where the propeller shafts and the tube shafts are fitted with continuous liners, or approved oil sealing glands, or made of corrosion resistant material, the interval of survey is to be:~~

~~— single shafting arrangement: three (3) years~~

~~— multi-shafting arrangements: four (4) years~~

~~The interval for drawing may be raised:~~

~~— from three (3) to a maximum of five (5) years for single shafting arrangements;~~

~~— from four (4) to a maximum of five (5) years for multi-shafting arrangements.~~

~~in any of the following three (3) cases:~~

~~— 1) where~~

~~— the propeller is fitted to a keyed shaft taper the design details of which are approved, and a non-destructive examination is made at each survey by an approved crack detection method of the after end of the cylindrical part of the shaft (from the after end of the liner, if any), and of about one third of the length of the taper from the large end, or~~

~~— 2) where~~

~~the propeller is fitted to a solid flange coupling at the aft end of the shaft, the shaft and its fittings are not exposed to corrosion, the design details are approved. Non-destructive examination of the fillet radius of the aft propeller shaft flange may be required if the visual examination of the area is not satisfactory, or~~

~~— 3) where~~

~~the propeller is fitted keyless to the shaft taper, the shaft is protected from seawater, the design details are approved, and a non-destructive examination is made at each survey by approved crack detection method of the forward part of the aft shaft taper.~~

~~— (ii) In all other cases, the interval of survey is to be 2 1/2 years (+/- 6 months).~~

~~B) The complete shaft is to be sufficiently drawn to permit entire examination.~~

~~However, for oil lubricated arrangement all exposed areas of the after shaft area as described in 1(a) are to be examined by an approved crack detection method without drawing of the shaft, where~~

~~— clearances and wear-down of the bearings,~~

~~— records of lubricating oil analysis, oil consumption and bearing temperature, and~~

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— ~~— visible shaft areas~~

are found satisfactory. The crack detection test of the aft flange fillet area may be dispensed with for the solid flange couplings fitted at the end of the shaft, see also 1(a)(i) 2).

2. ~~2.~~ Modified Survey

— ~~— A) For single and multi-shafting arrangements the modified survey may be accepted in any of the following three (3) cases subject to:~~

— ~~— the shaft is fitted with oil lubricated bearings and oil sealing glands, and~~

— ~~— the shaft and its fittings are not exposed to corrosion, and~~

— ~~— new oil seals may be fitted without removal of the propeller (except in the case of keyed propeller), and design details are approved.~~

— ~~— Where the propeller is keyed on the shaft taper and suitable crack-prevention measures are taken, or~~

— ~~— Where the propeller is fitted to a solid flange coupling at the end of the shaft, or~~

— ~~— Where the propeller is fitted keyless to the shaft taper.~~

B) The modified survey is accepted at alternate five (5) yearly (maximum) surveys instead of the Normal Survey, provided that the clearances of the aft bearing are found in order and the oil and the oil-sealing arrangements have proved effective.

C) The modified survey consists of:

— ~~— drawing the shaft to expose the aft bearing contact area of the shaft,~~

— ~~— examining the forward bearing as far as possible and all accessible parts of the shaft including the propeller connection to the shaft, and~~

— ~~— for keyed propellers, performing a non-destructive examination by an approved crack-detection method of about one third of the length of the taper from the big end, for which dismantling of the propeller will be required.~~

— ~~— for keyless propellers performing a visual examination to confirm the good condition of the sealing arrangements.~~

— ~~— D) Where a lubricating oil analysis is carried out regularly at intervals not exceeding six (6) months, and the oil consumption and bearing temperature are recorded and considered to be within permissible limits, drawing of the shaft to expose the aft bearing contact area of the shaft may not be required.~~

— ~~— The documentation on lubricating oil analysis is to be available on board. Each analysis should include the minimum parameters:~~

— ~~— water content,~~

— ~~— chlorides content,~~

— ~~— content of bearing metal particles, and~~

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(cont)

~~_____ oil aging (resistance to oxidation).~~

~~_____ Oil samples should be taken under service conditions.~~

3. ~~Partial Survey~~

~~_____ A) For shafts where the modified survey is applicable, consideration may be given, upon application by the Owner, to a prolongation of the intervals between Normal Survey, provided a partial survey is performed.~~

~~_____ B) The partial survey consists of checking the oil sealing glands and the clearance of the bearings. For keyed propellers, the propeller is to be dismantled to expose the forward part of the taper and a non-destructive examination by an approved crack-detection method is to be performed.~~

~~_____ C) In no case is the interval between Normal Survey to exceed 1.5 times the due interval.~~

~~Note: _____ Special consideration may be given in application of relevant sections of this Unified Requirement to commercial vessels owned or chartered by Governments, which are utilized in support of military operations or service.~~

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