

# 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.
5. Changes introduced in Rev.4 are to be uniformly implemented from 1 January 2017.

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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 the requirements 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 includes:

- 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

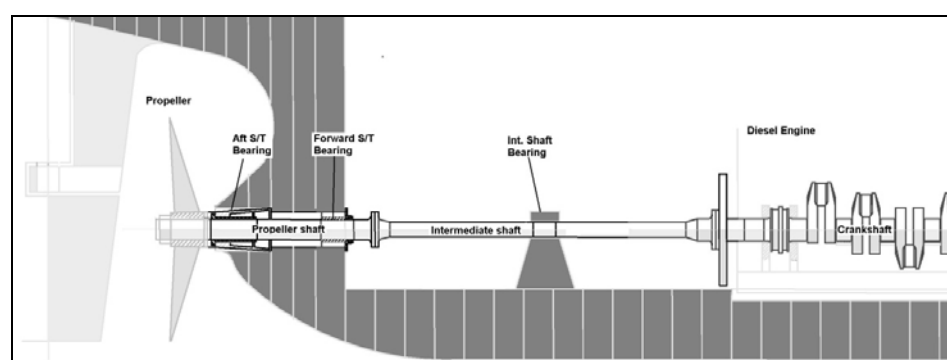
Propeller shaft is the part of the propulsion shaft to which the propeller is fitted. It may also be called screwshaft or tailshaft.

#### 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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(cont)**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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(cont)**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**

Shafting arrangements such as, but not limited to, an approved Condition Monitoring Scheme and / or other reliable approved means for assessing and monitoring the condition of the tail shaft, bearings, sealing devices and the stern tube lubricant system capable to assure the condition of the propeller shaft assembly with an equivalent level of safety as obtained by survey methods as applicable in IACS UR Z21.

**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.

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- 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.
- 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.

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(cont)**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.
- 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).

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- 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.

**2.2.2 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.



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- 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.

**2.3 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 (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).

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(cont)**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. In the event an additional extension is requested the requirements of the “2.5 year extension” are to be carried out and the shaft survey due date, prior to the previous extension(s), is extended for a maximum of 2.5 years.
- 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” or “2.5 years 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 or 2.5 years.

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).

**Z21**  
(cont)**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:

- 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. In the event an additional extension is requested the requirements of the "2.5 year extension" are to be carried out and the shaft survey due date, prior to the previous extension(s), is extended for a maximum of 2.5 years.
- 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" or "2.5 years 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 or 2.5 years.

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.

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## 2.5 TABLE of Survey Intervals (closed systems)

SURVEY INTERVALS (closed systems)			
Oil Lubricated			
	Flanged Propeller Coupling	Keyless Propeller Coupling	Keyed Propeller Coupling <sup>b</sup>
Every five years <sup>a</sup>	Method 1 or Method 2 or Method 3	Method 1 or Method 2 or Method 3 <sup>c</sup>	Method 1 or Method 2
Extension 2.5 Y	Yes <sup>d</sup>	Yes <sup>d</sup>	Yes <sup>d</sup>
Extension 1 Y	Yes <sup>e</sup>	Yes <sup>e</sup>	Yes <sup>e</sup>
Extension 3 M	Yes <sup>f</sup>	Yes <sup>f</sup>	Yes <sup>f</sup>
Closed Loop System Fresh Water Lubricated			
	Flanged Propeller Coupling	Keyless Propeller Coupling	Keyed Propeller Coupling <sup>b</sup>
Every five years <sup>a</sup>	Method 1 <sup>g</sup> or Method 2 or Method 3	Method 1 <sup>g</sup> or Method 2 or Method 3	Method 1 <sup>g</sup> or Method 2
Extension 2.5 Y	Yes <sup>d</sup>	Yes <sup>d</sup>	Yes <sup>d</sup>
Extension 1 Y	Yes <sup>e</sup>	Yes <sup>e</sup>	Yes <sup>e</sup>
Extension 3 M	Yes <sup>f</sup>	Yes <sup>f</sup>	Yes <sup>f</sup>
<p><b>General notes:</b>            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.            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.</p> <p><b>Notes:</b>            a: unless an Extension type (Extension 2.5 Y, Extension 1 Y, Extension 3 M) is applied in between.            b: Method 3 not allowed.            c: 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.            d: no more than one extension can be granted. No further extension of other type can be granted.            e: no more than two consecutive extensions can be granted. In the event an additional extension is requested the requirements of the "2.5 year extension" are to be carried out and the shaft survey due date, prior to the previous extension(s), is extended for a maximum of 2.5 years.            f: 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" or "2.5 years 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 or 2.5 years.            g: The maximum interval between two surveys carried out according to Method 1 shall not be more than 15 years.</p>			

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(cont)**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.

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(cont)**3.3.1.2 Other systems**

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)

SURVEY INTERVALS (open systems)			
<b>- Single Shaft operating exclusively in Fresh Water.</b> <b>- Single Shaft provided with adequate means of corrosion protection, Single corrosion resistant shaft.</b> <b>- All kinds of Multiple shafts arrangements.</b>		<b>Other shaft configuration.</b>	
All kinds of Propeller Coupling <sup>d</sup>		All kinds of Propeller Coupling <sup>d</sup>	
Every five years <sup>a</sup>	Method 4	Every three years <sup>a</sup>	Method 4
Extension 1 Y	Yes <sup>b</sup>	Extension 1 Y	Yes <sup>b</sup>
Extension 3 M	Yes <sup>c</sup>	Extension 3 M	Yes <sup>c</sup>
<p><b>General notes:</b>            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.            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.</p> <p><b>Notes:</b>            a: unless an Extension type (Extension 1 Y, Extension 3 M) is applied in between.            b: no more than one extension can be granted. No further extension, of other type, can be granted.            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.            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</p>			

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