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Ships and marine technology — Aquatic nuisance species — In-line sampling method for obtaining representative samples of water systems

Navires et technologie maritime — Méthode de prélèvement direct pour obtenir des échantillons représentatifs des systèmes d'eau

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Foreword

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The committee responsible for this document is ISO/ TC 8 Ships and marine technology/ WG 12 Aquatic nuisance species.

Introduction

A fully developed flow of ballast water in a ship's discharge piping is needed in order to obtain samples that represent the discharge. Fluid dynamics dictates that for different pipeline shapes and diameters, a specified length of straight pipeline is needed in order to obtain this flow prior to the ship's sampling port. Due to engine room configurations, footprints, and layout, required lengths of straight pipeline are not always available. The use of a straightener can overcome these limitations. This standard provides guidance on the straightener.

Ships and marine technology — Aquatic nuisance species — In-line sampling method for obtaining representative samples of water systems

1 Scope

This document provides guidance to port state control, surveyors, manufacturers and stakeholders on the types and installation of a straightener in the ballast water discharge piping. The straightener will enable a true representation of the whole fluid in the pipeline prior to the ship's sampling port.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11711-1, *Ships and marine technology – Aquatic nuisance species – Part 1: Ballast water discharge sampling port*

Resolution MEPC 279(70), Guidelines for approval of ballast water management systems (G8)

Resolution MEPC 173(58), Guidelines for ballast water sampling (G2)

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
ballast water
water with its suspended matter taken on board a ship to control trim, list, draught, stability or stresses of the ship

3.2
ballast water management system (BWMS)
any system which processes ballast water such that it meets the ballast water performance standard in regulation D-2 of the International Convention for the Control of Ships' Ballast Water and Sediments 2004

3.3
fully developed flow region
region which viscous effects and velocity changes are negligible

3.4
computational fluid dynamics (CFD)
the prediction of the behaviour of fluids by numerical methods rather than model experiments

3.5
straightener
a mixer to form a fully developed (laminar) flow

4 Sampling location

The sampling point shall be safely accessible to commission staff, and shall not be in a confined space. In-line sampling should be conducted where fully-developed flow is generated in a pipeline. The sampling point shall be installed in a straight part of the discharge line, downstream of the last treatment process, as near to the ballast water overboard discharge as practicable in horizontal flow or in ascending flow direction. Flow rate, viscosity and friction in the pipeline affect the generation of fully-developed flow. These factors cause irregular velocity distribution and turbulence. However, the irregular velocity distribution and turbulence could be stabilized over a certain distance in a straight pipeline. Therefore, in-line sampling should be conducted at the proper location in order to be representative to identify the characteristics of the entire fluid.

4.1 Types of pipeline

In general, four types of curved pipelines may be installed on ships such as "L" – curved shape (L-type), "U" – curved shape (U-type), "S" – curved shape (S-type) and twice curved "S" shape (S2-type) at the main discharge pipelines (see Figure 1). To assure representativeness, the in-line sample should be collected at the fully developed water flow region because irregular velocity and turbulence is normally induced when ballast water passes through a curved pipeline.

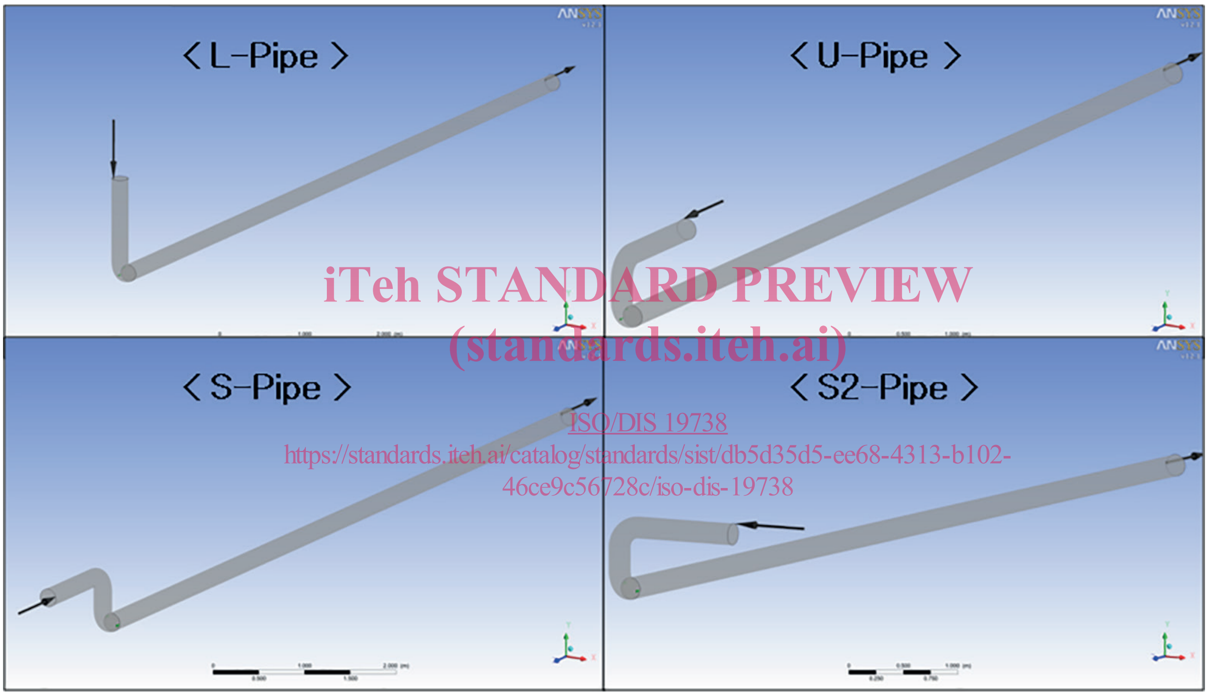

Figure 1 — Four types of curved pipeline installed on actual ship

NOTE Other types of curved pipeline may be encountered that may generate turbulence, for example, different bend angles.

4.2 Computing method of sampling location

Sampling port should be installed at straight region from the curved pipeline as follows:

$$L = L_f \times D_m$$

where

L: required straight length for installation of the in-line sampling port (m)

L_f: fully developed flow length depends on the velocity and type of pipeline ($4{,}4 \times (Re)^{1/6}$)

Re: $DV\rho/\mu$

D: inner diameter of pipe (m)

V: average flow velocity in pipe (m/s)

ρ: fluid density (kg/m^3)

μ: fluid viscosity (kg/m·s)

D_m: diameter of the main pipe (m)

Table 1 — Theoretical minimum straight length required to induce a fully developed flow region based on pipe type and inner diameter

Type of pipe (inner diameter)		Straight (developed flow) length for installation of sampling port L_f [1] x D_m [2] = L (metres)	
	In-line velocity (m/s)	No straightener	Straightener
L (100 mm)	1	(29,55 x 100) mm = 2,96 m	(6,00 x 100) mm = 0,60 m
	2	(33,18 x 100) mm = 3,32 m	(8,00 x 100) mm = 0,80 m
	3	(35,49 x 100) mm = 3,55 m	(8,00 x 100) mm = 0,80 m
	4	(37,24 x 100) mm = 3,72 m	(10,00 x 100) mm = 1,00 m
L (200 mm)	1	(33,21 x 200) mm = 6,64 m	(7,00 x 200) mm = 1,40 m
	2	(37,26 x 200) mm = 7,45 m	(8,00 x 200) mm = 1,60 m
	3	(39,85 x 200) mm = 7,97 m	(9,00 x 200) mm = 1,80 m
	4	(41,76 x 200) mm = 8,35 m	(9,00 x 200) mm = 1,80 m
L (300 mm)	1	(35,48 x 300) mm = 10,64 m	(5,00 x 300) mm = 1,50 m
	2	(39,81 x 300) mm = 11,94 m	(5,00 x 300) mm = 1,50 m
	3	(42,59 x 300) mm = 12,78 m	(6,00 x 300) mm = 1,80 m
	4	(44,68 x 300) mm = 13,40 m	(6,00 x 300) mm = 1,80 m
L (400 mm)	1	(37,24 x 400) mm = 14,89 m	(4,00 x 400) mm = 1,60 m
	2	(41,79 x 400) mm = 16,72 m	(4,00 x 400) mm = 1,60 m
	3	(44,70 x 400) mm = 17,88 m	(4,00 x 400) mm = 1,60 m
	4	(46,89 x 400) mm = 18,76 m	(4,00 x 400) mm = 1,60 m
L (500 mm)	1	(38,64 x 500) mm = 19,32 m	(3,00 x 500) mm = 1,50 m
	2	(43,36 x 500) mm = 21,68 m	(3,00 x 500) mm = 1,50 m
	3	(46,39 x 500) mm = 23,19 m	(3,00 x 500) mm = 1,50 m
	4	(48,66 x 500) mm = 24,33 m	(3,00 x 500) mm = 1,50 m
L (600 mm)	1	(39,83 x 600) mm = 23,89 m	(2,50 x 600) mm = 1,50 m
	2	(44,69 x 600) mm = 26,82 m	(2,50 x 600) mm = 1,50 m
	3	(47,81 x 600) mm = 28,69 m	(2,50 x 600) mm = 1,50 m
	4	(50,16 x 600) mm = 30,09 m	(2,50 x 600) mm = 1,50 m
U (200 mm)	4	(41,85 x 200) mm = 8,37 m	(16,00 x 200) mm = 3,20 m
S (200 mm)	4	(41.85 x 200) mm = 8,37 m	(14,00 x 200) mm = 2,80 m
S2 (200 mm)	4	(41,91 x 200) mm = 8,38 m	(17,00 x 200) mm = 3,40 m

1 Theoretical entrance distance

2 Inner diameter of pipeline