INTERNATIONAL STANDARD

First edition 2017-08

Ships and marine technology — Test method of flow induced in-pipe noise source characteristics for a shipused pump

Navires et technologie maritime — Méthode pour déterminer les caractéristiques des sources de bruit induites par l'écoulement dans **iTeh ST**les tuyaux d'une pompe de navire W

(standards.iteh.ai)

ISO 20155:2017 https://standards.iteh.ai/catalog/standards/sist/240ca1a3-d255-465d-ae53-175adba81fle/iso-20155-2017



Reference number ISO 20155:2017(E)

iTeh STANDARD PREVIEW (standards.iteh.ai)

ISO 20155:2017 https://standards.iteh.ai/catalog/standards/sist/240ca1a3-d255-465d-ae53-175adba81fle/iso-20155-2017



© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office Ch. de Blandonnet 8 • CP 401 CH-1214 Vernier, Geneva, Switzerland Tel. +41 22 749 01 11 Fax +41 22 749 09 47 copyright@iso.org www.iso.org

Page

Contents

Introduction v 1 Scope 1 2 Normative references 1 3 Terms and definitions 1 4 Two-port source model and test method of source characteristic of pump 2 4.1 Two-port source model of a pump 2 4.1 Two-port source characteristic parameters of the pump 2 4.1 Test methods for source characteristic parameters of the pump 2 5.1 Test toop 4 5.2 Installation of test pump 5 5.3 Ground foundation and supporting structure 6 5.4 Test section 6 5.5 Test section 6 5.6 Throttling valve 6 5.7 Secondary acoustic exciter 7 5.8 Water tank 7 6 Instrumentation 7 6.1 General Tene STANDARD PREVIEW 7 6.3 Dynamic measurements. 7 6.3 Dynamic measurements. 7 6.3 Dynamic measurements. 7 6.3 Dy	Forev	rord	iv
1 Scope 1 2 Normative references 1 3 Terms and definitions 1 4 Two-port source model and test method of source characteristic of pump 2 4.1 Two-port source model of a pump 2 4.2 Test methods for source characteristic parameters of the pump 3 5 Test rig. 4 5.1 Test toop 4 5.2 Installation of test pump 5 5.3 Ground foundation and supporting structure 6 5.4 Test-bed pipeline 6 5.5 Test section 6 5.6 Throtting valve 7 5.8 Water tank 7 6 Instrumentation 7 6.1 General Test proparation 7 Test proparation ISO 20152017 8 Test procedure/standot stat/action/stat/action	Intro	luction	v
2 Normative references 1 3 Terms and definitions 1 4 Two-port source model of a pump 2 4.1 Two-port source model of a pump 2 4.2 Test methods for source characteristic parameters of the pump 2 5.1 Test telop 4 5.1 Test tolop 4 5.2 Installation of test pump 5 5.3 Ground foundation and supporting structure 6 5.4 Test section 6 5.5 Test section 6 5.6 Throttling valve 6 5.7 Secondary acoustic exciter 7 5.8 Water tank 7 6 Instrumentation 7 6.1 Instrumentation 7 7 Test preparation ISO 20155/2017 8 Test procedure extender test ist of noise source 9 9 Data processing 175adball flefso-20155/2017 9 9 12 General 9 9 9 9.1 General informative of noise source	1	Scope	
3 Terms and definitions 1 4 Two-port source model and test method of source characteristic of pump 2 4.1 Two-port source model of a pump 2 4.2 Test methods for source characteristic parameters of the pump 3 5 Test rig 4 5.1 Test loop 4 5.2 Installation of test pump 5 5.3 Ground foundation and supporting structure 6 5.4 Test-bed pipeline 6 5.5 Test section 6 5.6 Throttling valve 6 5.7 Secondary acoustic exiter 7 5.8 Water tank 7 6 Instrumentation 7 6.1 General 7 7 Test preparation ISO 20155/2017 8 Test procedurge/standards/tenarctar/streactor/standards/standard	2	Normative references	
4 Two-port source model and test method of source characteristic of pump 2 4.1 Two-port source model of a pump 2 4.2 Test methods for source characteristic parameters of the pump 3 5 Test rig 4 5.1 Test loop. 4 5.2 Installation of test pump 5 5.3 Ground foundation and supporting structure 6 5.4 Test-bed pipeline 6 5.5 Test section 6 5.6 Throttling valve 6 5.7 Secondary acoustic exciter 7 5.8 Water tank 7 6 Instrumentation 7 6.1 Generall Test procedurge//standards.tenaicatalogstanthedysts/240ca1a3-t255-465d-ae53- 7 Test procedurge//standards.tenaicatalogstanthedysts/240ca1a3-t255-465d-ae53- 8 9 Data processing 1/// Sachasi file/so-20155-2017 9 9 9.1 General 9 9 9 9.2 Passive characteristic of noise source 9 9 9.3 Active characteristic of noise source <t< td=""><td>3</td><td>Terms and definitions</td><td></td></t<>	3	Terms and definitions	
4.1 Two-port source model of a pump 2 4.2 Test methods for source characteristic parameters of the pump 3 5 Test rig 4 5.1 Test loop 4 5.2 Installation of test pump 5 5.3 Ground foundation and supporting structure 6 5.4 Test bed pipeline 6 5.5 Test section 6 5.6 Thor thing valve 6 5.7 Secondary acoustic exciter 7 5.8 Water tank 7 6 Instrumentation 7 6.1 General 12 Ch. STANDARD PREVIEW 7 6.3 Dynamic measure freibtin dards.ifeh.ai) 7 Test preparation 180 201552017 8 Test procedurg/standards.ich.ai/catalogstandards/star240ca1a3-d255-465d-ac53- 9 Data processing 17.5adbs/10.e/so.20155-2017 9 9.1 General 9 9.1 General 9 9 9 Active characteristic 9 9 9.1 General information <t< td=""><td>4</td><td>Two-port source model and test method of source characteristic of pump</td><td>2</td></t<>	4	Two-port source model and test method of source characteristic of pump	2
4.2 Test methods for source characteristic parameters of the pump. 3 5 Test rig. 4 5.1 Test loop. 4 5.2 Installation of test pump. 5 5.3 Ground foundation and supporting structure. 6 5.4 Test bed pipeline. 6 5.5 Ground foundation and supporting structure. 6 5.4 Test section. 6 5.5 Test section. 6 5.6 Thortuling valve. 6 5.7 Secondary acoustic exciter. 7 5.8 Water tank. 7 6 Instrumentation. 7 6.1 General. 7 7 Test preparation. 7 8 Test procedure./stantards.ict.ni/catlogstantards.ist/240ca1a-d255-405d-dc53- 8 9 Data processing. 175adbs/11e/so-2017 9 9.1 General. 9 9 9.2 Passive characteristic 9 9.1 General. 9 9 9.2 Passive characteristic 9	•	4.1 Two-port source model of a pump	2
5 Test rig. 4 5.1 Test loop. 4 5.2 Installation of test pump 5 5.3 Ground foundation and supporting structure. 6 5.4 Test section 6 5.5 Test section 6 5.6 Throttling valve 6 5.7 Secondary acoustic exciter 7 5.8 Water tank 7 6 Instrumentation 7 6.1 General Tent STANDARD PREVIEW 7 6.2 Static measurements. 7 6.3 Dynamic measurements. 7 6.3 Dynamic measurements. 7 6.3 Dynamic measurements. 7 7 Test preparation ISO 20155/2017 8 Test procedure.standards ich alcataly standards issi/240catu/3-d255-405d-ac53- 9 Data processing 175d/dba810.cf/so-20155-2017 9 9.1 General 9 9.1 General 9 9.2 Passive characteristic of noise source 9 9.3 Active characteristic <td></td> <td>4.2 Test methods for source characteristic parameters of the pump</td> <td>3</td>		4.2 Test methods for source characteristic parameters of the pump	3
5.1rest toop45.2Installation of test pump55.3Ground foundation and supporting structure65.4Test-bed pipeline65.5Test section65.6Throttling valve65.7Secondary acoustic exciter75.8Water tank76Instrumentation76.1General Tech STANDARD PREVIEW76.2Static measurements76.3Dynamic measurements77Test preparationISO 2015520178Test procedure/standards/sit/240ca1a/3 d255-465d-ac5389Data processing175adballfle/sco-20155-201799.1General99.2Passive characteristic of noise source999.3Active characteristic910Evaluation criteria for the test result911Test record1011.1Overview1011.2General information1011.3Test record1111.4Test result11Annex A (informative) Theoretical models of a two-port source and transformation1311.1Annex D (informative) Formulae for determining passive characteristics of noise source19Annex D (informative) Formulae for determining active characteristics of source20Annex F (informative) Formulae for determining active characteristics of source20Annex F (informative) Verification of test method taking a T-shaped so	5	Test rig	
5.3 Ground foundation and supporting structure 6 5.4 Test-bed pipeline 6 5.5 Test section 6 5.6 Throttling valve 6 5.7 Secondary acoustic exciter 7 5.8 Water tank 7 6 Instrumentation 7 6.1 General 7 6.3 Dynamic measurements 7 6.3 Dynamic measurements 7 6.3 Dynamic measurements 7 7 Test preparation 8 7 Test preparation 8 9 Data processing 175adba81Re/so-20155-2017 9 9.1 General 9 9.1 General 9 9 9.2 Passive characteristic of noise source 9 9.3 Active characteristic 9 10 Evaluation criteria for the test result 9 11 Test report 10 11.1 Overview 10 11.2 General information 10 <t< td=""><td></td><td>5.1 lest loop 5.2 Installation of test numn</td><td></td></t<>		5.1 lest loop 5.2 Installation of test numn	
5.4 Test-bed pipeline 6 5.5 Test section 6 5.6 Throttling valve 6 5.7 Secondary acoustic exciter 7 5.8 Water tank 7 6 Instrumentation 7 6.1 General Teb STANDARD PREVIEW 7 6.2 Static measurements 7 6.3 Dynamic measurements 7 6.3 Dynamic measurements 7 6.3 Dynamic measurements 7 6.3 Dynamic measurements 7 7 Test preparation ISO 201552017 8 Test procedure/standards/sist240ca1a3-d255-465d-ac53- 8 9 Data processing 175adba8111c/so-20155-2017 9 9.1 General 9 9 9 9 9 9.1 General 10 11 10 11.1 0 verview 10 11.1 Overview 10 11.2 General information 10 11.2 General information 10 11.2 General information		5.3 Ground foundation and supporting structure	
5.5 Test section 6 5.6 Throttling valve 6 5.7 Secondary acoustic exciter 7 5.8 Water tank 7 6 Instrumentation 7 6.1 General Test STANDARD PREVIEW 7 6.2 Static measurements 7 6.3 Dynamic measurements 7 6.3 Dynamic measurements 7 6.3 Test preparation 80 20155 2017 7 Test preparation 80 20155 2017 8 Test procedure/standards ista/sist240ca1a3-d255-465d-ac53 8 9 Data processing 175adba81fle/iso-20155-2017 9 9.1 General 9 9 9.2 Passive characteristic of noise source 9 9.3 Active characteristic 9 10 Evaluation criteria for the test result 9 11 Test record 11 11.1 Overview 10 11.2 General information 10 11.3 Test record 11 11.4 <t< td=""><td></td><td>5.4 Test-bed pipeline</td><td></td></t<>		5.4 Test-bed pipeline	
5.6 Throttling valve 6 5.7 Secondary acoustic exciter 7 5.8 Water tank. 7 6 Instrumentation 7 6.1 General Teh STANDARD PREVIEW 7 6.2 Static measurements 7 6.3 Dynamic measurements 7 7 Test preparation 7 7 Test procedure/(standards:itchai/catalysistrudards:itchai/cataly-doc		5.5 Test section	
5.7 Secondary acoustic exciter 7 5.8 Water tank. 7 6 Instrumentation. 7 6.1 General Teh STANDARD PREVIEW 7 6.2 Static measurements. 7 6.3 Dynamic measurements. 7 6.3 Dynamic measurements. 7 6.3 Dynamic measurements. 7 6.3 Dynamic measurements. 7 7 Test preparation ISO 20155:2017 8 Test procedure.//standards.itelvai/catalog/standards/sist/240ca1a3-d255-465d-ac53- 8 9 Data processing 175adba81fle/iso-20155-2017 9 9.1 General 9 9 9 9 9 9 Data processing 175adba81fle/iso-20155-2017 9 9 9 9 9 9 9 1 General 9 9 9 1 General 9 9 1 10 11.1 10 11.1 10 11.1 10 11.2 General information 10 11.1 11.4 Test record 11		5.6 Throttling valve	
6 Instrumentation 7 6.1 General Teh STANDARD PREVIEW 7 6.2 Static measurements. 7 6.3 Dynamic measure(ments. 7 7 Test preparation 8 7 Test procedure.//standards.ich.ai/catalog/standards/sist/240cata3-d255-465d-ac53- 8 9 Data processing 175adba81fle/iso-20155-2017 9 9.1 General 9 9 9 9.2 Passive characteristic of noise source 9 9 9.3 Active characteristic of noise source 9 9 10 T1.1 Overview 10 11 11.1 Overview 10 11 10 11.2 General information 10 11 11 11.4 Test report 10 11 11 11.4 Test result 11 11 </td <td></td> <td>5.7 Secondary acoustic exciter</td> <td></td>		5.7 Secondary acoustic exciter	
6 Instrumentation / 6.1 General 7 6.2 Static measurements 7 6.3 Dynamic measurements 7 6.3 Dynamic measurements 7 6.3 Dynamic measurements 7 7 Test preparation 8 8 Test procedure/standards/istrumatory/standards/istr/240caha3/d255-465d-ac53- 8 9 Data processing 175adba81fle/iso-20155-2017 9 9.1 General 9 9 9.2 Passive characteristic of noise source 9 9 9.1 General 9 9 9.2 Passive characteristic 9 9 10 Evaluation criteria for the test result 9 11 Test report 10 11 11.1 Overview 10 11 11.2 General information 10 11 11.3 Test record 11 11 11.4 Test record 11 11 11.4 Test record 11 11	~		
6.1 Static measurements. 7 6.3 Dynamic measure (heber n clarify reference) 7 7 Test preparation 8 8 Test procedure//standards/sist240ca1a3-d255-465d-ac53- 8 9 Data processing 175adba81fle/so-20155-2017 9 9.1 General 9 9.2 Passive characteristic of noise source. 9 9.3 Active characteristic. 9 10 Evaluation criteria for the test result 9 11 Test report. 10 11.1 Overview 10 11.2 General information 10 11.3 Test record 11 11.4 Test record 11	0	61 Ceneral Toh STANDARD PREVIEW	
6.3 Dynamic measure(refets in dards.iteh.ai) 7 7 Test preparation 8 8 Test procedupe/standards/site/240ca1a3-d255-465d-ae53- 8 9 Data processing 175adba811e/iso-20155-2017 9 9 9.1 General 9 9.2 Passive characteristic of noise source 9 9 9.1 General 9 9.2 9.2 Passive characteristic 9 9 10 Evaluation criteria for the test result 9 11 Test report 10 11.2 General information 10 11.3 Test record 11 11.4 Test result 10 11.3 Test record 11 11.4 Test result 11 Annex A (informative) Theoretical models of a two-port source and transformation mutually between matrix Z, S, T 13 Annex B (informative) Evaluation of quantities at inlet and outlet ports 15 Annex C (informative) Formulae for determining passive characteristics of noise source 19 Annex E (informative) Formulae for determining active characteristics of source <td< td=""><td></td><td>6.2 Static measurements</td><td></td></td<>		6.2 Static measurements	
7 Test preparation ISO 20155:2017 8 8 Test procedure//standards/stel/alog/standards/stel/40cer1a3-d255-465d-ac53- 8 9 Data processing 175adba81fle/iso-20155-2017 9 9 9.1 General 9 9.2 Passive characteristic of noise source 9 9 9.3 Active characteristic 9 910 Evaluation criteria for the test result 9 10 Evaluation criteria for the test result 9 11 Test report 10 11.1 Overview 10 11.2 General information 10 11.3 Test record 11 11.4 Test result 11 11.4 Test result 11 11.4 Test result 11 11.4 Test result 13 Annex B (informative) Theoretical models of a two-port source and transformation mutually between matrix Z, S, T 13 Annex C (informative) Judgment of effectiveness for the test 17 Annex D (informative) Formulae for determining passive characteristics of noise source 19 Annex		6.3 Dynamic measurements nd ards.iteh.ai)	7
8 Test procedure//standards/ich al/catalog/standards/ist/240ca1a3-d255-465d-ac53- 8 9 Data processing 175adba81fle/iso-20155-2017 9 9 9.1 General 9 9.2 Passive characteristic of noise source 9 9.3 Active characteristic 9 10 Evaluation criteria for the test result 9 11 Test report 10 11.1 Overview 10 11.2 General information 10 11.3 Test record 11 11.4 Test result 11 11.4 Test result 11 11.4 Test record 11 11.4 Test result 11 Annex B (informative) Foromulae of quantities at inlet and outlet ports.	7	Test preparation	
9 Data processing 175adba81fle/iso-20155-2017 9 9.1 General 9 9.2 Passive characteristic of noise source 9 9.3 Active characteristic 9 10 Evaluation criteria for the test result 9 11 Test report 10 11.1 Overview 10 11.2 General information 10 11.3 Test record 11 11.4 Test result 11 11.5 Annex B (informative) Theoretical models of a two-port source and transformation mutually between matrix Z, S, T 13 Annex C (informative) Judgment of effectiveness for	8	ISO 20155:2017 Test procedure //ctondomic.itab.mi/contando/ctondomica2.ud255.u465/t-2053	
9.1 General 9 9.2 Passive characteristic of noise source 9 9.3 Active characteristic 9 10 Evaluation criteria for the test result 9 11 Test report 10 11.1 Overview 10 11.2 General information 10 11.3 Test record 11 11.4 Test result 10 11.3 Test record 11 11.4 Test result 11 11.4 Test result 11 11.4 Test result 11 Annex A (informative) Theoretical models of a two-port source and transformation mutually between matrix Z, S, T 13 Annex B (informative) Evaluation of quantities at inlet and outlet ports 15 Annex C (informative) Formulae for determining passive characteristics of noise source 19 Annex E (informative) Formulae for determining active characteristics of source 20 Annex F (informative) Verification of test method taking a T-shaped sound excitor as a two-port acoustic source 21 Bibliography 24	9	Data processing 175adba81fle/iso-20155-2017	9
9.2Passive characteristic of noise source99.3Active characteristic910Evaluation criteria for the test result911Test report1011.1Overview1011.2General information1011.3Test record1111.4Test result1111.4Test result1111.4Test result1111.4Test result1111.5Theoretical models of a two-port source and transformation mutually between matrix Z, S, T13Annex B (informative) Evaluation of quantities at inlet and outlet ports15Annex D (informative) Judgment of effectiveness for the test17Annex D (informative) Formulae for determining passive characteristics of noise source19Annex F (informative) Verification of test method taking a T-shaped sound excitor as a two- port acoustic source21Bibliography24	,	9.1 General	
9.3 Active characteristic 9 10 Evaluation criteria for the test result 9 11 Test report 10 11.1 Overview 10 11.2 General information 10 11.3 Test record 11 11.4 Test record 11 11.4 Test result 11 11.5 Annex B (informative) Evaluation of quantities at inlet and outlet ports 15 Annex D (informative) Formulae for determining active characteristics		9.2 Passive characteristic of noise source	9
10 Evaluation criteria for the test result 9 11 Test report 10 11.1 Overview 10 11.2 General information 10 11.3 Test record 11 11.4 Test result 11 11.5 Annex A (informative) Theoretical models of a two-port source and transformation mutually between matrix Z, S, T 13 Annex B (informative) Evaluation of quantities at inlet and outlet ports 15 Annex C (informative) Judgment of effectiveness for the test 17 Annex E (informative) Formulae for determining active characteristics of source 20 Anne		9.3 Active characteristic	9
11 Test report 10 11.1 Overview 10 11.2 General information 10 11.3 Test record 11 11.4 Test result 11 Annex A (informative) Theoretical models of a two-port source and transformation mutually between matrix Z, S, T 13 Annex B (informative) Evaluation of quantities at inlet and outlet ports 15 Annex C (informative) Judgment of effectiveness for the test 17 Annex D (informative) Formulae for determining passive characteristics of noise source 19 Annex F (informative) Verification of test method taking a T-shaped sound excitor as a two-port acoustic source 21 Bibliogranhy 24	10	Evaluation criteria for the test result	9
11.1Overview1011.2General information1011.3Test record1111.4Test result11Annex A (informative) Theoretical models of a two-port source and transformation mutually between matrix Z, S, T13Annex B (informative) Evaluation of quantities at inlet and outlet ports15Annex C (informative) Judgment of effectiveness for the test17Annex D (informative) Formulae for determining passive characteristics of noise source19Annex F (informative) Verification of test method taking a T-shaped sound excitor as a two- port acoustic source21Bibliography24	11	Test report	
11.2 General information 10 11.3 Test record 11 11.4 Test result 11 Annex A (informative) Theoretical models of a two-port source and transformation 11 Mutually between matrix Z, S, T 13 Annex B (informative) Evaluation of quantities at inlet and outlet ports 15 Annex C (informative) Judgment of effectiveness for the test 17 Annex D (informative) Formulae for determining passive characteristics of noise source 19 Annex E (informative) Formulae for determining active characteristics of source 20 Annex F (informative) Verification of test method taking a T-shaped sound excitor as a two-port acoustic source 21 Bibliography 24		11.1 Overview	
11.3 Test record 11 11.4 Test result 11 Annex A (informative) Theoretical models of a two-port source and transformation 11 mutually between matrix Z, S, T 13 Annex B (informative) Evaluation of quantities at inlet and outlet ports 15 Annex C (informative) Judgment of effectiveness for the test 17 Annex D (informative) Formulae for determining passive characteristics of noise source 19 Annex E (informative) Formulae for determining active characteristics of source 20 Annex F (informative) Verification of test method taking a T-shaped sound excitor as a two-port acoustic source 21 Bibliography 24		11.2 General information	
Annex A (informative) Theoretical models of a two-port source and transformation mutually between matrix Z, S, T 13 Annex B (informative) Evaluation of quantities at inlet and outlet ports 15 Annex C (informative) Judgment of effectiveness for the test 17 Annex D (informative) Formulae for determining passive characteristics of noise source 19 Annex E (informative) Formulae for determining active characteristics of source 20 Annex F (informative) Verification of test method taking a T-shaped sound excitor as a two-port acoustic source 21 Bibliography		11.3 IESt record	11 11
Annex A (informative) Theoretical models of a two-port source and transformation mutually between matrix Z, S, T 13 Annex B (informative) Evaluation of quantities at inlet and outlet ports 15 Annex C (informative) Judgment of effectiveness for the test 17 Annex D (informative) Formulae for determining passive characteristics of noise source 19 Annex E (informative) Formulae for determining active characteristics of source 20 Annex F (informative) Verification of test method taking a T-shaped sound excitor as a two-port acoustic source 21 Bibliography	A	1.1 (informative) Theoretical models of a two next courses and transformation	
Annex B (informative) Evaluation of quantities at inlet and outlet ports 15 Annex C (informative) Judgment of effectiveness for the test 17 Annex D (informative) Formulae for determining passive characteristics of noise source 19 Annex E (informative) Formulae for determining active characteristics of source 20 Annex F (informative) Verification of test method taking a T-shaped sound excitor as a two-port acoustic source 21 Bibliography 24	Anne	mutually between matrix Z, S, T	
Annex C (informative) Judgment of effectiveness for the test 17 Annex D (informative) Formulae for determining passive characteristics of noise source 19 Annex E (informative) Formulae for determining active characteristics of source 20 Annex F (informative) Verification of test method taking a T-shaped sound excitor as a two-port acoustic source 21 Bibliography 24	Anne	B (informative) Evaluation of quantities at inlet and outlet ports	
Annex D (informative) Formulae for determining passive characteristics of noise source	Anne	c (informative) Judgment of effectiveness for the test	
Annex E (informative) Formulae for determining active characteristics of source 20 Annex F (informative) Verification of test method taking a T-shaped sound excitor as a two-port acoustic source 21 Bibliography 24	Anne	x D (informative) Formulae for determining passive characteristics of noise source	
Annex F (informative) Verification of test method taking a T-shaped sound excitor as a two- port acoustic source 21 Bibliography 24	Anne	x E (informative) Formulae for determining active characteristics of source	
Ribliography 24	Anne	F (informative) Verification of test method taking a T-shaped sound excitor as a two-	
	Rihlid	granhy	24

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html. (standards.iteh.ai)

This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 8, *Ship design*. https://standards.iteh.ai/catalog/standards/sist/240ca1a3-d255-465d-ae53-

175adba81fle/iso-20155-2017

Introduction

In hydraulic fluid power systems of ships, power is transmitted through a liquid under pressure. Pumps are components that convert rotary mechanical power into hydraulic fluid power. During the process of converting mechanical power into hydraulic power, flow and pressure fluctuations and structure-borne vibrations are generated. These fluid-borne and structure-borne vibrations, which are generated primarily by the unsteady flow produced by the pump, are transmitted through the connected piping system.

The fluid-borne vibration generated by a pump is called pressure ripple or flow induced noise. For pumps used for coolant and drainage in ships, flow induced noise can be transmitted along the piping and radiated into the surrounding water area through a pipe mouth outboard the ship, which produces noise pollution and disturbs the environment including marine mammals.

The level of flow induced noise for a pump depends upon not only the characteristics of the pump itself, but also the circuit in which the pump is installed. Thus, the determination of flow induced noise by a pump is complicated by the interaction between the pump and the circuit. The directly measured data using hydrophones inserted in pipe reaches connecting the pump cannot reflect noise source characteristics of the pump. The method adopted to measure the flow induced noise of a pump should be such as to eliminate the interaction.

ISO 10767-1 and ISO 10767-2 provide the test methods for the positive displacement pump with the precision and simplified method, respectively, where the pump is treated as a single port acoustic source and its source characteristics expressed by two parameters of source strength as well as source impedance can be obtained. For other common pumps with two ports, the sound field between the inlet and outlet of a pump is inter-coupling, source characteristics cannot be fully expressed by two parameters, but expressed by up to six parameters, tel source pressures at the inlet and outlet of a pump and four elements in a 2×2 impedance matrix. There is a need to establish a new standard about a test method for noise source characteristics of a pump, based on two-port acoustic source model.

The source characteristics of flow induced noise are used for evaluating the hydrodynamic noise feature of the pump. The measured results can be compared for pumps of different types and manufacture. This will enable the pump designer to evaluate the effects of design modifications and help hydraulic system designers to avoid selecting pumps having high noise levels.

The method is based upon the application of plane wave transmission line theory to the analysis of noise propagation in hydraulic systems. By adopting a two-port model with noise source and evaluating the impedance characteristics of the pump using a secondary-source method, it is possible to obtain the source strength of the pump, independent of the circuit that the pump locates.

iTeh STANDARD PREVIEW (standards.iteh.ai)

ISO 20155:2017 https://standards.iteh.ai/catalog/standards/sist/240ca1a3-d255-465d-ae53-175adba81fle/iso-20155-2017

Ships and marine technology — Test method of flow induced in-pipe noise source characteristics for a shipused pump

1 Scope

This document specifies a test method for determining flow induced in-pipe noise source characteristics of a ship-used pump as a two-port sound source in laboratory conditions by measuring acoustic pressures in the pipe reaches of inlet and outlet.

The test method is applicable to all types of centrifugal pumps with a diameter over 50 mm operating under steady conditions.

The suitable frequency range of the test method is about 10 Hz to 1 000 Hz, and the upper frequency is dependent on the inner diameter of the pipe, in which the plane acoustic wave propagates.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 10767-1:2015, Hydraulic fluid power — Determination of pressure ripple levels generated in systems and components — Part 1: Method for determining source flow ripple and source impedance of pumps

https://standards.iteh.ai/catalog/standards/sist/240ca1a3-d255-465d-ae53-IEC 60565, Underwater acoustics — Hydrophones — Calibration in the frequency range 0,01 Hz to 1 MHz

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at <u>http://www.electropedia.org/</u>

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1

two-port source

test object with inlet and outlet which are inter-coupling acoustically

3.2

passive characteristic

acoustic characteristic of a test object only acting as a transmission path, which can be indicated by different manners such as a transfer matrix, impedance matrix, scattering matrix, etc.

3.3

active characteristic

acoustic characteristic of a test object which provides acoustic energy into a piping system

Note 1 to entry: Depending on the adopted theoretical model, active characteristics can be represented by acoustic pressure source, volume velocity source, etc.

3.4

test section

pipe reaches which are used to fix the hydrophones, measuring the in-pipe noise from the acoustic source

3.5

static pressure in pipe

fluid pressure in pipe as fluid is in still, which is one of the parameters describing the working conditions of the test object

3.6

working flowrate

fluid volume or mass per unit time, which is one of the working parameters of the test object

3.7

pressure drop/hydraulic loss

static pressure difference between the inlet and outlet as the fluid passes through the test object, which is a reference parameter for analysis use

3.8

foundation

platform built by ferroconcrete, used to install the experimental facility and test objects, including ground basis, guide rail for convenient mount of pipeline

4 Two-port source model and test method of source characteristic of pump

iTeh STANDARD PREVIEW

4.1 Two-port source model of a pump (standards.iteh.ai)

It is assumed that only plane wave would transmit in the pipeline, and the noise source characteristic of a pump could be described by linear superposition of active and passive characteristic. Based on the electro-acoustic analogy and acoustic transmission line theory, there are three different models to characterize a two-port source, which can be called "Transmission model", "Impedance model" and "Scattering model". They are illustrated in Annex A.



Key

- 1 flow
- 2 source
- 3 pipe
- 4 inlet
- 5 outlet

Figure 1 — Two-port noise source model

Adopting the impedance model, the radiating sound from the inlet and outlet into pipe can be expressed by <u>Formula (1)</u>:

$$\begin{pmatrix} P_{o} \\ P_{i} \end{pmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{pmatrix} Q_{o} \\ Q_{i} \end{pmatrix} + \begin{pmatrix} P_{so} \\ P_{si} \end{pmatrix} = \mathbf{Z} \begin{pmatrix} Q_{o} \\ Q_{i} \end{pmatrix} + \begin{pmatrix} P_{so} \\ P_{si} \end{pmatrix}$$
(1)

where

- $P_{\rm s}$, $Q_{\rm s}$ is the real sound source of a pump providing sound pressure and volumetric velocity into the inlet and outlet of the pump, while the connected pipes are unlimited or anechoic;
- P_{0}, Q_{0} is the sound pressure and volumetric velocity at the outlet of acoustic source, respectively;
- P_i, Q_i is the sound pressure and volumetric velocity at the inlet of acoustic source, respectively;
- P_{so} , P_{si} is the sound pressure source which indicate radiating sound from the inlet and outlet into pipe;

Z is the impedance matrix,
$$Z = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}$$
.

4.2 Test methods for source characteristic parameters of the pump

Using the secondary-source method, turn on the secondary doustic source on one side (inlet or outlet), get and register signals from the four hydrophones. Then, move it to another side and turn it on, register signals of the four hydrophones again. By this procedure, matrix parameter *Z* can be derived. Finally, turn off the source active characteristic parameters p_{10} and q_{2} of the pump can be obtained utilizing the result of matrix parameter *Z*. 175adba81fle/iso-20155-2017



Key

- 1 secondary source 1
- 2 secondary source 2
- 3 test pump
- 4 hydrophones H_1 to H_6

Figure 2 — Sketch of dual-position acoustic source methods

In Figure 2, H_1 to H_6 are six hydrophones along the pipe mounted at positions x_1 to x_6 , correspondingly.

The procedure for measuring source characteristics is given as follows.

a) Turn on the secondary acoustic source at the inlet for the following result:

where superscript ⁽¹⁾ indicates the corresponding quantities obtained by turning on the secondary sound source at the first time, and they can be obtained by means of calculation using formulae in <u>Annex B</u>, which correlate the quantities with the measured signals from hydrophones.

b) Turn on the secondary acoustic source at the outlet for the following result:

$$\begin{pmatrix} P_{o}^{(2)} \\ P_{i}^{(2)} \end{pmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{pmatrix} Q_{o}^{(2)} \\ Q_{i}^{(2)} \end{pmatrix}$$
(3)

where superscript ⁽²⁾ indicates the corresponding quantities obtained by turning on the secondary sound source at the second time.

c) Combine <u>Formulae (2)</u> and <u>(3)</u> and solve the equation system, the impedance matrix *Z* can be calculated.

$$\begin{pmatrix} P_{o}^{(1)} & P_{o}^{(2)} \\ P_{i}^{(1)} & P_{i}^{(2)} \end{pmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{pmatrix} Q_{o}^{(1)} & Q_{o}^{(2)} \\ Q_{i}^{(1)} & Q_{i}^{(2)} \end{pmatrix} DARD PREVIEW$$
(4)

d) Turn off the secondary acoustic source, and let the measured pump operate under the needed conditions, the active source parameters, i.e. sound pressure source P_{so} , P_{si} can be obtained according to Formula (5).

 $\begin{pmatrix} P_{so} \\ P_{si} \end{pmatrix} = \begin{pmatrix} P_{o} \\ P_{i} \end{pmatrix} - \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{pmatrix} standards.iteh.ai/catalog/standards/sist/240ca1a3-d255-465d-ae53-175adba81fle/iso-20155-2017 \\ Q_{i} \end{pmatrix}$ (5)

At the right side of Formula (5), P_0 , P_i and Q_0 , Q_i are obtained by calculation using the measured signals from hydrophones during pump operation.

5 Test rig

5.1 Test loop

Figure 3 shows the schematic of test circuit of flow induced in-pipe noise source characteristic of the pump.



Figure 3 — Sketch of test circuit for measuring flow-noise source characteristic of the pump

In the schematic diagram, a water tank is used for separating sound waves from the inlet and outlet of pump. A throttling valve is used for flowrate adjustment and located between the water tanks for reducing the effect on source characteristic measurement of the pump. A secondary acoustic exciter can provide an external acoustic source for determination of passive features of the pump, and the vibration damper can suppress the vibration of the test section from the neighbouring pipe reaches. Hydrophones are mounted in test sections at the inlet and outlet of the pump for measuring the acoustic pressure in the pipeline.

5.2 Installation of test pump

The test pump should be installed as recommended by the manufacturer and mounted in such a manner that the response of the mounting-to-pump vibration is minimized.

In order to reduce vibration disturbance from the ground and the connected pipe, the pump should be installed on the foundation through vibration isolators and connected to the pipeline with flexible insertions. The isolators and flexible insertions should be chosen close to the actual conditions.

The prime mover and associated drive couplings shall not generate torsional vibration in the pump shaft. If necessary, the pump and the driving unit shall be isolated from each other to eliminate vibration generated by the prime mover.

5.3 Ground foundation and supporting structure

Ground foundation should be made of reinforced concrete and isolated to the surrounding ground in the laboratory such as foundations of other auxiliary equipment. A supporting structure of the pipeline is also required to be rigidly connecting the pipeline with the ground foundation.

5.4 Test-bed pipeline

The pipeline shall be composed of uniform, rigid, straight metal pipes at each port of the pump.

The inner diameters of the test pipeline at inlet and outlet should be equal to that of the inlet and outlet of the test pump respectively. In the case of the inequality of inner diameter between the test pump and pipeline, the adaptor connecting the pump ports to the pipe shall have an internal diameter which does not differ from the pipe diameter by more than 10 % at any point. Any such variations in internal diameter shall occur over a length not exceeding twice the internal diameter of the pipe. The adaptor shall be arranged in order to prevent the formation of air pockets in it.

The bending section in the pipeline of Figure 3 shall adopt bends with bending radii larger than twice the radii of the pipe to reduce hydrodynamic noise arising from the flow over it.

The total length of the uniform straight pipeline in front of the inlet flange of the test pump should be 10 times larger than pipe diameter.

5.5 Test section

Each of the two test sections as a straight pipe reach is fixed on the inlet and outlet of the test pump respectively, with the length more than 2 m, the inner diameters, *D*, equal to that of inlet and outlet pipe of the test pump. The test section should be fabricated with a tube of wall thickness greater than 5 % of the inner diameters, *D*. In the test section, two or three hydrophones with equal interval are fixed on the pipe. Each hydrophone is put in a plug mounted on the pipe. In order to reduce interference from turbulence over the inner wall of the pipe, the hydrophones shall be mounted such that their diaphragms are flush with the inner wall of the pipe to within ± 0.5 mm. The sealing ring in the plug should be used between the hydrophone and plug body to prevent water leakage.

The distance between two or two of three hydrophones depends on the maximum frequency of the measurement frequency range and shall be given by Formula (6), to within 1 %:

$$x_2 - x_1 = \frac{\sqrt{B_{\text{eff}} \times 10^5 / \rho}}{(67 \times f_{0,\text{max}})} \tag{6}$$

where

 $f_{0,\max}$ is the maximum frequency of the measurement frequency range, in hertz;

 $B_{\rm eff}$ is the effective bulk modulus, in bars;

ho is the density, in kilograms per cubic meter.

Meanwhile, in order to avoid turbulent fluctuation pressure from the pump impacting directly on hydrophone, the nearest hydrophone should be positioned at a distance larger than 3 to 5 times pipe inner diameter from the test pump.

5.6 Throttling valve

The throttling valve should meet the need of flowrate adjustment. From the point of acoustic measurement, it should have a low noise level and no cavitation should appear under the test working conditions.