

ISO/FDIS 6398-1:2023(E)

ISO/TC 67/SC 4/WG 4

Secretariat: ANSI

Date: 2024-01-12/2023

**Oil and gas industries including ~~low~~lower carbon energy —
Submersible linear motor systems for artificial lift —**

**Part 1:
Submersible linear motor**

iTeh Standards
(<https://standards.itih.ai>)

Document Preview
FDIS stage

<https://standards.itih.ai/catalog/standards/iso/aa87bd98-8c36-4990-9167-d62bd216a72a/iso-fdis-6398-1>

© ISO ~~2023~~2024

All rights reserved. Unless otherwise specified, or required in the context of its implementation, 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
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: + 41 22 749 01 11
~~Email~~E-mail: copyright@iso.org
Website: www.iso.org

Published in Switzerland

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO/FDIS 6398-1](#)

<https://standards.iteh.ai/catalog/standards/iso/aa87bd98-8c36-4990-9167-d62bd216a72a/iso-fdis-6398-1>

Contents

Foreword	v
Introduction.....	vi
1 Scope	1
2 Normative references.....	1
3 Terms and definitions	1
4 Symbols and abbreviations.....	5
4.1 Abbreviated terms.....	5
4.2 Symbols.....	5
5 Functional specification	5
5.1 General	5
5.2 SLM type description.....	6
5.3 Functional requirements	6
5.3.1 General.....	6
5.3.2 Application parameters.....	6
5.3.3 Environmental compatibility	7
5.3.4 Compatibility with related well equipment and services.....	8
5.4 User/purchaser selections.....	9
5.4.1 General.....	9
5.4.2 Design validation.....	9
5.4.3 Functional evaluation.....	9
5.4.4 Quality grades.....	9
5.4.5 Shipping, handling, and storage.....	9
5.4.6 Additional documentation or requirements.....	10
6 Technical specification	10
6.1 General	10
6.2 Design criteria	10
6.2.1 General.....	10
6.2.2 Design documentation	10
6.2.3 Materials	11
6.2.4 Dimensional information.....	12
6.2.5 Design verification.....	12
6.2.6 Design validation.....	12
6.2.7 Functional evaluation requirements.....	13
6.2.8 Design changes.....	13
6.3 Technical specification — SLM.....	13

6.3.1	General.....	13
6.3.2	Technical characteristics	13
6.3.3	Performance rating	13
6.3.4	Scaling of design validation.....	14
7	Supplier's/manufacturer's requirements.....	14
7.1	General	14
7.2	Documentation information.....	14
7.2.1	General.....	14
7.2.2	Delivery documentation.....	14
7.2.3	Operation's manual	14
7.2.4	Product qualification certificate.....	15
7.2.5	Product data sheet.....	15
7.3	Electrical nameplate	16
7.4	Permanent component identification.....	16
7.5	Quality	16
7.5.1	General.....	16
7.5.2	Quality grade requirements.....	16
7.6	Raw materials.....	17
7.7	Traceability.....	17
7.8	Calibration systems.....	18
7.9	Examination and inspection.....	18
7.9.1	General.....	18
7.9.2	Weld.....	18
7.9.3	Dimensional inspection	19
7.10	Manufacturing non-conformity.....	20
7.11	Functional testing	20
8	Repair/redress.....	20
9	Shipping, handling, and storage.....	20
9.1	General	20
9.2	Storage.....	20
Annex A (normative)	Design validation performance rating requirements	22
Annex B (normative)	Functional evaluation.....	27
Annex C (informative)	Schematic of the test device	33
Annex D (informative)	Components of the submersible linear motor	39
Bibliography	41

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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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

For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Oil and gas industries including lower carbon energy*, Subcommittee SC 4, *Drilling, production and injection equipment*.

A list of all parts in the ISO 6398-1 series can be found on the ISO website. www.iso.org/iso/7-d62bd216a72a/iso-fdis-6398-1

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document has been prepared by users/purchasers and suppliers/manufacturers of submersible linear motors and is intended for use in the petroleum and natural gas industries worldwide. This document provides requirements and information to both parties in the selection, manufacturing, testing and use of submersible linear motors. Further, this document addresses supplier specifications. This document provides the components composition diagram of the submersible linear motor, see [Annex D](#).

This document provides the required levels for design validation, quality control and functional evaluation, allowing the user/purchaser to select each level for a specific application. According to different components, design confirmation is divided into two grades; quality control is divided into two grades; and functional evaluation is divided into two grades. For grades of design validation, quality control and functional evaluation, grade 2 is the lowest grade, and higher grades have additional requirements. The user/purchaser may specify supplementary specifications for these grades.

iTeh Standards (<https://standards.itih.ai>) Document Preview

[ISO/FDIS 6398-1](#)

<https://standards.itih.ai/catalog/standards/iso/aa87bd98-8c36-4990-9167-d62bd216a72a/iso-fdis-6398-1>

Oil and gas ~~industry~~**industries** including ~~low~~**lower** carbon energy — Submersible linear motor systems for artificial lift —

Part 1: Submersible linear motor

1 Scope

This document provides requirements for the design, design verification and validation, quality control, functional evaluations and storage of submersible linear motor (SLM) systems.

This document is applicable to components of submersible linear motors including stators, movers and motor lead extension cables.

This document also specifies design validation performance rating requirements and functional evaluation for SLM. ~~Additional.~~

Equipment not covered by this document includes pumps and other fittings, power cables and drive systems.

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 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 10893-4, *Non-destructive testing of steel tubes — Part 4: Liquid penetrant inspection of seamless and welded steel tubes for the detection of surface imperfections*

ISO 10893-5, *Non-destructive testing of steel tubes — Part 5: Magnetic particle inspection of seamless and welded ferromagnetic steel tubes for the detection of surface imperfections*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ASTM E94, *Standard Guide for Radiographic Examination*

ASME BPVC, Section V, *Nondestructive Examination*

3 Terms and definitions

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

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

- —ISO Online browsing platform: available at <https://www.iso.org/obp>
- —IEC Electropedia: available at <https://www.electropedia.org/>

3.1

bottom connection of stator

connecting part between the lower end of the *stator* (3.19(3.19)) and the stator base

3.2

corrosive environment

environment that contains one or more corrosive agents

[SOURCE: ISO 8044:2020, 3.3]

3.3

cushion

terminal buffer for the *mover* (3.9(3.9)) of a linear motor

3.4

design validation

process of proving a design by testing to demonstrate conformity of the product to design requirements and performance ratings

[SOURCE: ISO 15551:2023, 3.39]

3.5

design verification

process of examining the premise of a given design by calculation, comparison or investigation, to substantiate conformity with specified requirements

[SOURCE: ISO 15551:2023, 3.40]

3.6

maximum operating temperature

maximum ambient temperature at which the *submersible linear motor* (3.26(3.26)) can be operated as specified by the supplier/manufacturer

3.7

motor lead extension cable

cable connected to the *pothead* (3.13(3.13)) for splicing to the power cable

3.8

motor linear velocity

displacement of *mover* (3.9(3.9)) running per unit time

3.9

mover

shaft-shaped component of the *submersible linear motor* (3.26(3.26)) that carries on the back and forth movement in an operation

3.10

mover base

components with function of supporting the *mover* (3.9(3.9))

3.11**mover short joint**

joints between *mover* (3.9(3.9)) subs

3.12**mover straightness**

maximum deviation distance between the *mover* (3.9(3.9)) surface and the horizontal plane

3.13**pothead**

power connector on the end of the *motor lead extension cable* (3.7(3.7)) or power cable which mates to the motor

[SOURCE: ISO 15551:2023, 3.105]

3.14**qualified person**

individual with characteristics or abilities gained through training or experience or both as measured against established requirements, such as standards or tests that enable the individual to perform a required function

[SOURCE: ISO 15136-1:2009, 3.49]

3.15**rated power**

output power of the *submersible linear motor* (3.26(3.26)) under *rated voltage* (3.17(3.17)), *rated current* (3.18(3.18)) and *rated thrust* (3.16(3.16)), unit:kW

Note 1 to entry: Rated power is expressed in kW.

3.16**rated thrust**

maximum *thrust* (3.27(3.27)) value of the *submersible linear motor* (3.26(3.26)) for long-term stable operation

3.17**rated voltage**

optimal voltage of the *submersible linear motor* (3.26(3.26)) for long-term stable operation

3.18**rated current**

optimal current of the *submersible linear motor* (3.26(3.26)) for long-term stable operation

3.19**stator**

component of the *submersible linear motor* (3.26(3.26)) that is usually composed of *stator core* (3.20(3.20)), *stator electromagnetic winding* (3.21(3.21)), inner cylinder and housing

Note 1 to entry: Generally, the *stator core* (3.20(3.20)) and the *stator winding* (3.21(3.21)) are placed in the oil filled sealing cavity composed of the inner cylinder and the shell.

Note 2 to entry: When the *submersible linear motor* (3.26(3.26)) works, the stator remains stationary.

3.20

stator core

component of the stator (3.19) comprised of multiple steel lamination sheets through which copper or other electrical conducting material is wound and laminated to reduce eddy current loss

3.21

stator winding

conductive wire threaded through the *stator core (3.20(3.20))*

3.22

stator end cover

end cover at each end of a *stator (3.19(3.19))* sub

3.23

stator lead connector

lead connector of the series windings of the *stator (3.19(3.19))* of a *submersible linear motor (3.26(3.26))*

3.24

stator limit short section

joint that limits the *stator (3.19(3.19))* of a *submersible linear motor (3.26(3.26))*

3.25

stroke

maximum linear displacement of the *mover (3.9(3.9))* during operation

3.26

submersible linear motor

SLM

motor that directly converts electrical energy into mechanical energy for the linear motion needed to drive the plunger pump to do reciprocating work in a well—(abbreviated as SLM)

3.27

thrust

longitudinal acceleration force or deceleration force generated during operation of the *submersible linear motor (3.26(3.26))*

[SOURCE: IEC 62520-2011, 3.14]

3.28

top connection of mover

connecting part between the upper end of a *mover (3.9(3.9))* and the polished rod of a plunger pump

3.29

top connection of stator

uppermost connection part of the *stator (3.19(3.19))* sub in series

3.30

unique identifier

unique combination of alphanumeric characters to identify a specific component

[SOURCE: ISO 15136-1:2009, 3.70]

4 Symbols and abbreviations

4.1 ~~4.1~~ Abbreviated terms

AWG	American wire gauge
MD	measured depth
NDE	non- destructive examination
TVD	true vertical depth

4.2 ~~4.2~~ Symbols

K	constant, is 234,5 for copper conductor
R_{UV}	resistance value measured between U and V terminals of the winding
R_{VW}	resistance value measured between V and W terminals of the winding
R_{WU}	resistance value measured between W and U terminals of the winding
R_{med}	sum of the three phase DC resistances
R_U	U phase resistance of the winding
R_V	V phase resistance of the winding
R_W	W phase resistance of the winding
R_{mav}	average of the three phase DC resistances
R	single phase resistance of the winding
ε_{mR}	imbalance rate of the three-phase DC resistance
R_{max}	maximum value in R_U, R_V, R_W
R_{min}	minimum value in R_U, R_V, R_W
R_f	resistance of the winding at the time of motor de-energization
R_b	resistance of the winding before the test is started at a known stable temperature
T_{av}	Average average winding temperature rise
T_b	temperature at the time R_b is taken
T_f	temperature at the time R_f is taken

5 Functional specification

5.1 General

The user/purchaser shall prepare a functional specification to order products that conform to this document and shall specify the requirements and operating conditions as appropriate. The user/purchaser shall specify the units of measurement for the data provided. This information is used by the supplier/manufacturer to recommend the SLM.

SLM is designed for specific applications, when used in a new/different application, re-evaluation is required to ensure that the system works properly. The process used for this re-evaluation shall be no less stringent than that required for the initial application.

5.2 SLM type description

The user/purchaser shall request a SLM on the basis of the production requirements.

5.3 Functional requirements

5.3.1 General

The user/purchaser shall specify the known and anticipated application parameters and requirements. Operational issues that can have an effect on the systems operation and durability, such as rated power, rated voltage, rated current, rated thrust, stroke, minimum and maximum strokes per minute and other issues, shall also be specified.

5.3.2 Application parameters

5.3.2.1 General

While installed, the SLM system shall perform in accordance with its functional requirements, which are typically determined based on application parameters. These parameters include, but are not limited to, those listed in ~~5.3.2.2~~ to ~~5.3.2.3~~.

5.3.2.2 Well information

5.3.2.2.1 Requirement

The following well information, whether planned or existing, shall be specified:

- a) ~~a)~~ operating environment, such as ~~corrosion~~corrosive environment of downhole heavy oil and conventional oil production applications;
- b) ~~b)~~ well type, such as vertical, slant, deviated, or horizontal;
- c) ~~c)~~ wellhead location, such as onshore, platform, or subsea;
- d) ~~d)~~ reservoir type, such as carbonate, consolidated sandstone, unconsolidated sandstone or shale;
- e) ~~e)~~ reservoir recovery mechanism or process, such as water flooding, thermal recovery;
- f) ~~f)~~ production information, such as but not limited to fluid production, minimum expected well fluid flow rate, maximum expected bottom temperature, oil pressure, and casing pressure;
- g) ~~g)~~ existing or planned power supply details, such as generator/utility power, volts, frequency, kVA/Amp supply limitations;
- h) ~~h)~~ service-life expectation, such as days and repair cycle.

5.3.2.2.2 Supplemental Information

The following well information shall be specified, if available:

- a) ~~a)~~ well profile, such as inclination, "S shaped" and "U shaped";