

DIN EN ISO 15136-1

ICS 75.180.10

Ersatz für
DIN EN ISO 15136-1:2002-04**Erdöl- und Erdgasindustrie –
Exzentrerschneckenpump-Fördersysteme –
Teil 1: Pumpen (ISO 15136-1:2009);
Englische Fassung EN ISO 15136-1:2009**

Petroleum and natural gas industries –
Progressing cavity pump systems for artificial lift –
Part 1: Pumps (ISO 15136-1:2009);
English version EN ISO 15136-1:2009

Industries du pétrole et du gaz naturel –
Pompes de fond à cavités progressantes pour activation des puits –
Partie 1: Pompes (ISO 15136-1:2009);
Version anglaise EN ISO 15136-1:2009

Gesamtumfang 128 Seiten

Normenausschuss Erdöl- und Erdgasgewinnung (NÖG) im DIN

Nationales Vorwort

Dieses Dokument (EN ISO 15136-1:2009) wurde vom Technischen Komitee ISO/TC 67 „Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries“ in Zusammenarbeit mit dem Technischen Komitee CEN/TC 12 „Materialien, Ausrüstungen und Offshore-Bauwerke für die Erdöl-, petrochemische und Erdgasindustrie“ erarbeitet, dessen Sekretariat von AFNOR gehalten wird.

Für Deutschland hat hieran der Arbeitskreis NA 109-00-01 AK 4 „Bohr- und Fördereinrichtungen“ im Normenausschuss Erdöl- und Erdgasgewinnung (NÖG) mitgearbeitet.

Diese Europäische Norm enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die englische Originalfassung der ISO Norm.

Dieses Dokument enthält neben den gesetzlichen Einheiten auch die Einheiten °F, bbl, ppm, psi (psig), r/min, die im Deutschen Normenwerk nicht zugelassen sind. Es wird jedoch ausdrücklich darauf hingewiesen, dass die Anwendung dieser Einheiten im nationalen amtlichen und geschäftlichen Verkehr aufgrund des Gesetzes über Einheiten im Messwesen nicht zulässig ist.

Umrechnung:

Nicht-SI-Einheit	SI-Einheit	Umrechnung
°F	°C	$[(5/9) \cdot (°F-32)]$
bbl	dm ³	1 bbl = 158,987 dm ³
ppm	mg/kg	1 ppm = 1 mg/kg
psi (psig)	kPa	1 psi = 6,894 757 kPa
r/min	U/min	1 r/min = 1 U/min

Änderungen

Gegenüber DIN EN ISO 15136-1:2002-04 wurden folgende Änderungen vorgenommen:

- Aufnahme von Normativen Referenzen;
- Aufnahme der Abschnitte 8 „Repair“ und 9 „Shipping, handling and storage“;
- Erweiterung der normativen Anhänge auf Anhang A „Requirements for progressing cavity pump elastomers“, Anhang B „Design validation“ und Anhang C „Functional evaluation“;
- Erweiterung der informativen Anhänge auf Anhang D „Optional information for PCP elastomer testing and selection“, Anhang E „Installation guidelines“, Anhang F „Operational guidelines“, Anhang G „Supplemental information for PCP performance characteristics“, Anhang H „Example user/purchaser PCP functional specification form“, Anhang I „Analysis after use“, Anhang J „Selection and use of drive string equipment in PCP applications“, Anhang K „Repair and reconditioning“ und Anhang L „Auxiliary Equipment“;
- Norm redaktionell den derzeit gültigen Gestaltungsregeln angepasst.

Für die in diesem Dokument zitierten Internationalen Normen wird im Folgenden auf die entsprechenden Deutschen Normen hingewiesen:

ISO 34-1	siehe	DIN ISO 34-1
ISO 815-1	siehe	DIN ISO 815-1
ISO 2977	siehe	DIN ISO 2977
ISO 7743	siehe	DIN ISO 7743
ISO 11960	siehe	DIN EN ISO 11960
ISO 15136-2	siehe	DIN EN ISO 15136-2
ISO 15156 (all parts)	siehe	DIN EN ISO 15156 (alle Teile)

Frühere Ausgaben

DIN EN ISO 15136-1: 2002-04

Nationaler Anhang NA (informativ)

Begriffe

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

ANMERKUNG Hinsichtlich der in diesem Dokument verwendeten, jedoch nicht im Folgenden definierten, Begriffe im Zusammenhang mit Qualitätssicherungssystemen wird auf ISO 9000 verwiesen.

3.1

effektive Förderleistung in Abhängigkeit von der Drehzahl

durch Funktionsprüfung für ein spezifisches Produkt bestimmte volumetrische Förderleistung

ANMERKUNG „rpm“ (Drehzahl) wurde in diesem Begriff beibehalten, da es Teil der feststehenden industriellen Terminologie ist. Jedoch wird diese Abkürzung durch ISO als Einheit abgelehnt und wird daher in den entsprechenden Fällen in die anerkannte Form „r/min“ („U/min“) umgewandelt.

3.2

aufgebrachtes Drehmoment

Drehmoment, das durch das Oberflächenantriebssystem auf das obere Ende des Antriebsstrangs aufgebracht wird

3.3

künstliches Fördersystem

Aufbau aus Ausrüstungsteilen, der verwendet wird, um Fluide aus einer Untergrundformation an die Oberfläche zu fördern, und der Folgendes umfassen kann: Pumpe, Antriebsstrang, Antriebsmaschine und Steigrohrstrang

3.4

Hilfsausrüstung

Ausrüstung oder Bauelemente, die außerhalb des Anwendungsbereichs dieses Teils von ISO 15136 liegt/en und üblicherweise durch den Nutzer/Käufer ausgewählt und/oder eingebaut wird/werden

BEISPIELE Anschlagstangen, Gasabscheider und Drehmomentanker.

3.5

Boden-Antriebssystem

Bohrlochsohlen-Antriebssystem

Untertage-Antriebssystem

PCP-Antriebssystem, bei dem eine Untertage-Antriebsmaschine zum Einsatz kommt

3.6

Futterrohr

Rohr, das an der Oberfläche beginnt und dafür vorgesehen ist, die Wände eines Bohrlochs auszukleiden

3.7

Futterrohrgröße

Nenn-Außendurchmesser des Futterrohrs entsprechend der Festlegung in ISO 11960

3.8

Kernablenkung

radialer Versatz der Achsline des Statorhohlraums gegenüber der Achsline des Statorrohrs

3.9**korrosive Umgebung**

Betriebsumgebung, in der die Kombination aus Temperatur und chemischen Agenzien eine qualitative Verschlechterung der Ausrüstung verursacht

3.10**Auslegungs-Validierung**

Prozess der Bestätigung einer Auslegung durch Prüfung, um die Konformität des Produkts mit den Auslegungsanforderungen nachzuweisen

3.11**Auslegungs-Verifizierung**

Prozess der Überprüfung der Voraussetzungen für eine gegebene Auslegung durch Berechnung, Vergleich oder Untersuchung, um die Konformität mit festgelegten Anforderungen nachzuweisen

3.12**Bohrloch-Abweichung****Bohrloch-Krümmung**

lokalisierte Bohrlochkrümmung

3.13**Differenzdruck**

Differenz zwischen Ansaug- und Förderdruck der Pumpe

3.14**Untertage-Förderleistung bezogen auf die Drehzahl**

auf der Grundlage von Berechnungen und der unter Tage vorliegenden Bedingungen abgeschätzte volumetrische Förderleistung

ANMERKUNG „rpm“ (Drehzahl) wurde in diesem Begriff beibehalten, da es Teil der etablierten industriellen Terminologie ist. Jedoch wird diese Abkürzung durch ISO als Einheit abgelehnt und wird daher in den entsprechenden Fällen in die anerkannte Form „r/min“ („U/min“) umgewandelt.

3.15**Antriebsstrang**

Vorrichtung zur Kraftübertragung (in der Regel Pumpgestänge) zwischen dem Oberflächenantriebssystem und der Exzentrerschneckenpumpen

3.16**belegte Hohlräume**

Anzahl der durch die Wechselwirkung zwischen Rotor und Stator gefüllten Hohlräume

3.17**defekte Einheit**

jede Einheit, die versagt hat

3.18**Versagen**

Ende der Fähigkeit einer Einheit, eine geforderte Funktion zu erfüllen

3.19**Versagensdeskriptor**

offensichtliche, beobachtete Auswirkung des Versagens (einer defekten Einheit)

3.20**Ausfallursache**

Umstände während der Auslegungs-, der Fertigungs- oder der Nutzungsphase, die zu einem Versagen geführt haben

3.21

Durchsatz

Fluidvolumen, das je Zeiteinheit gepumpt wird

3.22

Reibungsdrehmoment

Widerstand gegenüber der Rotation des Antriebsstrangs (im Steigrohr) und des Rotors (im Stator), der von Faktoren wie z. B. Bohrlochtiefe und Abwurfkurve, Pumpengeometrie und Presspassung zwischen Rotor und Stator sowie Stopfbuchsenmerkmalen abhängt

3.23

Funktion

Arbeitsweise eines Produkts während des Einsatzes

3.24

Funktionsspezifikation

Merkmale, Eigenschaften, Prozessbedingungen, Grenzen und Ausschlüsse, durch die die Anforderungen an das Leistungsverhalten und an die Anwendung der Ausrüstung festgelegt sind

3.25

Funktionsprüfung

zur Bestätigung des ordnungsgemäßen Betriebs der Ausrüstung durchgeführte Prüfverfahren

3.26

Grad

Kategorie oder Klasse/Stufe, die zum Zwecke der Qualitäts- oder Auslegungs-Validierung in Bezug auf unterschiedliche Anforderungen vergeben wird

3.27

Nenndruckhöhe

Druckhöhe, angegeben in Form der äquivalenten Wassersäule

3.28

hydraulisches Drehmoment

durch den Differenzdruck über die Pumpe hervorgerufenes Drehmoment

3.29

Einsatzpumpe

PCP, bei der der Stator durch den Steigrohrstrang in das Bohrloch eingeführt wird

3.30

(Betrachtungs-)Einheit

jedes Teil, Bauelement, Gerät oder Teilsystem, jede Funktionseinheit, jedes Betriebsmittel oder System, das/die für sich allein betrachtet werden kann

3.31

Herstellung

durch einen Ausrüstungslieferanten/-hersteller ausgeführte Prozesse und Tätigkeiten, die erforderlich sind, um fertige Bauelemente und Baugruppen sowie die zugehörige Dokumentation bereitzustellen, und die die Erfordernisse des Nutzers/Käufers erfüllen und den Normen des Lieferanten/Herstellers entsprechen

ANMERKUNG Die Herstellung beginnt, wenn der Lieferant/Hersteller einen Auftrag erhält, und endet in dem Moment, in dem die Bauelemente/Baugruppen und die zugehörige Dokumentation einem Transportunternehmen übergeben werden.

3.32

höchste zulässige Arbeitsgeschwindigkeit

höchste Betriebsgeschwindigkeit der Pumpe, wie vom Lieferanten/Hersteller festgelegt

3.33**höchste zulässige Arbeitstemperatur**

höchste Betriebstemperatur der Pumpe, wie vom Lieferanten/Hersteller festgelegt

3.34**Modell**

Betriebsmittel mit individuellen Bauelementen und Betriebsmerkmalen, durch die es sich von weiteren Betriebsmitteln derselben Bauart unterscheidet

3.35**Drehmomentsperre****Antidrehmomentwerkzeug**

verhindert ein Ausweichen des PCP-Stators und/oder des Steigrohrs aufgrund des durch die Presspassung zwischen Rotor und Stator verursachten Drehmoments

3.36**Nennförderleistung in Abhängigkeit von der Drehzahl**

veröffentlichte volumetrische Förderleistung, die auf theoretischen Berechnungen beruht und für kommerzielle Zwecke angepasst wurde

ANMERKUNG „rpm“ (Drehzahl) wurde in diesem Begriff beibehalten, da es Teil der etablierten industriellen Terminologie ist. Jedoch wird diese Abkürzung durch ISO als Einheit abgelehnt und wird daher in den entsprechenden Fällen in die anerkannte Form „r/min“ („U/min“) umgewandelt.

3.37**Nichtkonformität**

Nichterfüllung einer festgelegten Anforderung, beispielsweise die Abweichung einer Ausrüstung, eines Teils, einer Vorgehensweise oder eines Verfahrens von einer eingeführten Norm

3.38**Betreiber**

Nutzer der Ausrüstung

3.39**Betriebshandbuch**

durch den Lieferanten/Hersteller herausgegebene Publikation, die ausführliche Daten und Anleitungen hinsichtlich Auslegung, Einbau, Betrieb und Wartung der Ausrüstung enthält

3.40**Betriebsumgebung**

Reihe von Bedingungen, denen das Produkt über seinen gesamten Lebenszyklus ausgesetzt ist

3.41**Orbitalrohr****Umlaufrohr**

überdimensionierter Abschnitt des Steigrohrstrangs unmittelbar oberhalb des Stators

3.42**PCP-Geometrie**

individuelle Kombination aus Steigung, Exzentrizität und Durchmesser

3.43**Nennleistung**

Bemessung der hydraulischen Leistung der Pumpe

3.44**Nenndruck**

Bemessungsdifferenzdruck

3.45

defekte Primäreinheit

defekte Einheit in der PCP, die das Versagen der Pumpe auslöst

3.46

Antriebsmaschine

Motor (üblicherweise hydraulischer, elektrischer oder Verbrennungsmotor), der das Drehmoment für die Rotationsbewegung des Pumpenrotors liefert

3.47

Exzentrerschneckenpumpe

PCP

in einem Bohrloch eingebaute und aus einem Stator und einem Rotor bestehende Pumpe, deren Geometrie im zusammengebauten Zustand so beschaffen ist, dass mindestens zwei Reihen von linsenförmigen, spiralförmig verlaufenden, separaten Hohlräumen entstehen

3.48

zugelassenes Teil

anerkanntes Teil

Teil, das im Rahmen eines zugelassenen Qualitätssicherungsprogramms hergestellt wurde und das, sofern es als Ersatzteil eingesetzt wird, die Leistung des ursprünglichen Teils erreicht oder überschreitet

3.49

qualifizierte Person

Individuum, das Eigenschaften oder Fähigkeiten aufweist, die es durch Ausbildung, Erfahrung oder beides erworben hat und die es in die Lage versetzen, eine geforderte Funktion auszuführen, wobei als Bewertungsgrundlage anerkannte Anforderungen wie beispielsweise Normen oder Prüfungen gelten

3.50

Ausbaugrund

Veranlassung zum Herausziehen der Pumpe aus dem Bohrloch

3.51

Sanierung

Überholung

Wiederherstellung

jegliche auf den Ersatz zugelassener Teile beschränkte Tätigkeiten

3.52

Reparatur

jegliche über den Geltungsbereich der Sanierung hinausgehende Tätigkeiten, einschließlich Demontage, Remontage und Prüfung, mit oder ohne Ersatz zugelassener Teile; sie kann maschinelle Bearbeitung, Schweißen, Wärmebehandlung oder sonstige fertigungsbezogene Arbeitsschritte umfassen, durch die die ursprüngliche Leistung der Ausrüstung wiederhergestellt wird

3.53

geforderte Funktion

Funktion oder Kombination von Funktionen einer Einheit, die für das Erbringen einer vorgegebenen Leistung als notwendig erachtet wird

3.54

Rotor

gewendelte konturierte Welle

3.55

Rotor-Einphasungsschablone

kurzes Werkstoffsegment, das so geformt ist, dass es dem Rotorprofil entspricht

3.56**wesentliche Auslegungsänderung**

vom Lieferanten/Hersteller identifizierte Änderung bezüglich der Auslegung, durch die das Leistungsverhalten des Produkts unter den vorgesehenen Betriebsbedingungen beeinflusst wird

3.57**Größe**

relevante maßbezogene Eigenschaften der Ausrüstung entsprechend den Festlegungen des Lieferanten/Herstellers

3.58**diskontinuierliche Förderung**

durch inhomogenen Durchsatz gekennzeichnete Bohrlochförderung

3.59**Stator**

Rohrsegment mit gewendelter konturierter Innenoberfläche, das mit einem Rotor im Eingriff steht und dabei eine Reihe linsenförmiger Hohlräume entlang des Rohres bildet

3.60**Stator-Einphasungsschablone**

kurzes Werkstoffsegment, das so geformt ist, dass es dem Statorkernprofil entspricht

3.61**Quellprozess**

Volumenzunahme eines Elastomers, die auftritt, wenn sich aufgrund der physikalischen Wechselwirkungen zwischen Fluid und Elastomer das Fluid im Material verteilt

3.62**Anschlagstange**

am Boden des Stators befestigte Baugruppe, die die Distanz beschränkt, über die der Rotor über das Ende des Stators hinausragen kann

ANMERKUNG Auch bekannt als Stoppbuchse.

3.63**Technische Spezifikation**

Anforderungen, die die Ausrüstung erfüllen muss, um der Funktionsspezifikation zu entsprechen

3.64**Prüfdruck**

Druck, bei dem die Ausrüstung auf Grundlage sämtlicher zutreffender Auslegungskriterien geprüft wird

3.65**Prüftemperatur**

Temperatur, bei der die Ausrüstung auf Grundlage sämtlicher zutreffender Auslegungskriterien geprüft wird

3.66**Drehmomentanker**

Gerät, das ein Ausweichen des PCP-Stators und/oder des Steigrohrs aufgrund des durch die Presspassung zwischen Rotor und Stator verursachten Drehmoments sowie die axiale Bewegung der Pumpe in Bezug auf das Futterrohr/den Liner des Bohrlochs verhindert

3.67**Steigrohr**

in einem Bohrloch angeordnetes Rohr, das als Förder- oder Einpresskanal dient

3.68

steigrohrgeführt

PCP-System, bei dem der Stator am Boden des Steigrohrstangs in das Bohrloch eingeführt wird

3.69

Bauart

Ausrüstung mit individuellen Eigenschaften, durch die sie sich von weiteren funktional vergleichbaren Ausrüstungen unterscheidet

3.70

eindeutiger Bezeichner

individuelle Kombination alphanumerischer Zeichen zur Identifizierung eines spezifischen Bauelements

3.71

validierte Förderleistung in Abhängigkeit von der Drehzahl

durch Prüfung im Zusammenhang mit der Auslegungs-Validierung bestimmte volumetrische Förderleistung

ANMERKUNG „rpm“ (Drehzahl) wurde in diesem Begriff beibehalten, da es Teil der etablierten industriellen Terminologie ist. Jedoch wird diese Abkürzung durch ISO als Einheit abgelehnt und wird daher in den entsprechenden Fällen in die anerkannte Form „r/min“ („U/min“) umgewandelt.

3.72

Bohrlochkopf

Ausrüstungsverbund, der übermäßig zur Aufrechterhaltung der Regulierung und Überwachung des Bohrlochs angewendet wird

ANMERKUNG Die Bohrlochkopfausrüstung umfasst Futterrohrköpfe (unterste und mittlere), Steigrohrköpfe, die Eruptionskreuz-Ausrüstung mit Ventilen und Armaturen sowie Futterrohr- und Steigrohrhänger und die zugehörige Ausrüstung.

Nationaler Anhang NB (informativ)

Literaturhinweise

DIN ISO 34-1, *Elastomere oder thermoplastische Elastomere — Bestimmung des Weiterreißwiderstandes — Teil 1: Streifen-, winkel- und bogenförmige Probekörper*

DIN ISO 815-1, *Elastomere oder thermoplastische Elastomere — Bestimmung des Druckverformungsrestes — Teil 1: Bei Umgebungstemperaturen oder erhöhten Temperaturen*

DIN ISO 2977, *Mineralölerzeugnisse und Lösemittel aus Kohlenwasserstoffen — Bestimmung des Anilinpunktes und Misch-Anilinpunktes*

DIN ISO 7743, *Elastomere oder thermoplastische Elastomere — Bestimmung des Druckverformungsverhaltens*

DIN EN ISO 11960, *Erdöl- und Erdgasindustrie — Stahlrohre zur Verwendung als Futter- oder Steigrohre für Bohrungen*

DIN EN ISO 15136-2, *Erdöl- und Erdgasindustrie — Exzentrerschnecken-tiefpump-Fördersysteme — Teil 2: Übertage-Antriebssysteme*

DIN EN ISO 15156 (alle Teile), *Erdöl- und Erdgasindustrie — Werkstoffe für den Einsatz in H₂S-haltiger Umgebung bei der Öl- und Gasgewinnung*

— Leerseite —

English Version

Petroleum and natural gas industries — Progressing cavity
pump systems for artificial lift — Part 1: Pumps
(ISO 15136-1:2009)

Industries du pétrole et du gaz naturel — Pompes de fond
à cavités progressantes pour activation des puits —
Partie 1: Pompes (ISO 15136-1:2009)

Erdöl- und Erdgasindustrie — Exzentrerschnecken­tiefpump-
Fördersysteme — Teil 1: Pumpen (ISO 15136-1:2009)

This European Standard was approved by CEN on 28 October 2009.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents

	Page
Foreword.....	4
Introduction	5
1 Scope	6
2 Normative references	6
3 Terms and definitions	7
4 Abbreviated terms and symbols	13
5 Functional specification.....	15
5.1 General.....	15
5.2 PCP type description.....	15
5.3 Functional requirements	15
5.4 Design validation	19
5.5 Product functional evaluation	20
5.6 Quality control grades.....	20
5.7 Additional documentation	20
5.8 Additional requirements	20
6 Technical specification	20
6.1 General.....	20
6.2 Technical characteristics.....	21
6.3 Design criteria	21
6.4 Dimensional information.....	22
6.5 Performance ratings.....	23
6.6 Design verification.....	24
6.7 Design validation	24
6.8 Functional evaluation requirements	24
6.9 Allowable design changes.....	24
6.10 Scaling of design validation	25
7 Supplier/manufacturer requirements.....	25
7.1 General.....	25
7.2 Documentation and data control.....	25
7.3 Product identification.....	27
7.4 Quality	28
7.5 Raw materials certification	30
7.6 Additional processes applied to components.....	30
7.7 Traceability	30
7.8 Calibration systems.....	31
7.9 Examination and inspection	31
7.10 Manufacturing non-conformance.....	36
7.11 User/purchaser complaint returns	36
7.12 Product functional testing	36
8 Repair.....	36
9 Shipping, handling and storage	37
9.1 General.....	37
9.2 Preparation for shipment	37
9.3 Handling.....	37
9.4 Storage.....	38

Annex A (normative) Requirements for progressing cavity pump elastomers	39
Annex B (normative) Design validation	43
Annex C (normative) Functional evaluation	47
Annex D (informative) Optional information for PCP elastomer testing and selection	54
Annex E (informative) Installation guidelines	65
Annex F (informative) Operational guidelines	68
Annex G (informative) Supplemental information for PCP performance characteristics	76
Annex H (informative) Example user/purchaser PCP functional specification form	81
Annex I (informative) Analysis after use	84
Annex J (informative) Selection and use of drive-string equipment in PCP applications	98
Annex K (informative) Repair and reconditioning	105
Annex L (informative) Auxiliary equipment	108
Bibliography	113

Foreword

This document (EN ISO 15136-1:2009) has been prepared by Technical Committee ISO/TC 67 “Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries” in collaboration with Technical Committee CEN/TC 12 “Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries” the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2010, and conflicting national standards shall be withdrawn at the latest by May 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 15136-1:2001.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of ISO 15136-1:2009 has been approved by CEN as a EN ISO 15136-1:2009 without any modification.

Introduction

This part of ISO 15136 has been developed by users/purchasers and suppliers/manufacturers of progressing cavity pumps and is intended for use in the petroleum and natural gas industry worldwide. This part of ISO 15136 provides requirements and information to both parties in the selection, manufacturing, testing, and using progressing cavity pumps as defined in the scope. Further, this part of ISO 15136 addresses supplier requirements, which set the minimum parameters with which it is necessary that suppliers comply to claim conformity with this part of ISO 15136.

This part of ISO 15136 provides grades of requirements for design validation, quality control and functional evaluations allowing the user/purchaser to select each for a specific application. There are three grades of design validation and quality control, and two grades of functional testing. Design validation grade V3 is restricted to legacy products, the basic grade is V2 and the highest grade is V1. Quality control grade 3 is the standard grade and grades 2 and 1 provide additional requirements. Functional evaluation grade F1 requires a hydraulic test of the PCP and grade F2 does not. The user/purchaser has the option of specifying requirements supplemental to these grades.

It is necessary that the users of this part of ISO 15136 be aware that requirements above those outlined in this part of ISO 15136 can be needed for individual applications. This part of ISO 15136 is not intended to inhibit a supplier/manufacturer from offering, or the user/purchaser from accepting, alternative equipment or engineering solutions. This can be particularly applicable where there is innovative or developing technology. Where an alternative is offered, it is the responsibility of the supplier/manufacturer to clearly and completely identify any variations from the requirements of this part of ISO 15136.

IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.

1 Scope

This part of ISO 15136 provides requirements for the design, design verification and validation, manufacturing and data control, performance ratings, functional evaluation, repair, handling and storage of progressing cavity pumps for use in the petroleum and natural gas industry. This part of ISO 15136 is applicable to those products meeting the definition of progressing cavity pumps (PCP) included herein. Connections to the drive string and tubulars are not covered by this part of ISO 15136.

This part of ISO 15136 includes normative annexes that establish requirements for characterization and testing of stator elastomer material, design validation and functional evaluation. Additionally, informative annexes provide information for PCP elastomer selection and testing, installation, start-up and operation guidelines, equipment selection and application guidelines, functional specification form, used pump evaluation, drive string selection and use, repair and reconditioning procedures and auxiliary equipment.

Equipment not covered by the requirements of this part of ISO 15136 includes bottom-drive systems except for the PCP components, drive-string components and auxiliary equipment such as tag bars, gas separators and torque anchors. These items might or might not be covered by other International Standards. Surface-drive systems are covered in ISO 15136-2.

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 34-1, *Rubber, vulcanized or thermoplastic — Determination of tear strength — Part 1: Trouser, angle and crescent test pieces*

ISO 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 815-1:2008, *Rubber, vulcanized or thermoplastic — Determination of compression set — Part 1: At ambient or elevated temperatures*

ISO 2977, *Petroleum products and hydrocarbon solvents — Determination of aniline point and mixed aniline point*

ISO 4662, *Rubber, vulcanized or thermoplastic — Determination of rebound resilience*

ISO 4666 (all parts), *Rubber, vulcanized — Determination of temperature rise and resistance to fatigue in flexometer testing*

ISO 7619-1, *Rubber, vulcanized or thermoplastic — Determination of indentation hardness — Part 1: Durometer method (Shore hardness)*

ISO 7743, *Rubber, vulcanized or thermoplastic — Determination of compression stress-strain properties*

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

ISO 11960, *Petroleum and natural gas industries — Steel pipes for use as tubing or casing for wells*

ISO 15136-2, *Petroleum and natural gas industries — Progressing cavity pump systems for artificial lift — Part 2: Surface-drive systems*

ISO 15156 (all parts), *Petroleum and natural gas industries — Materials for use in H₂S-containing environments in oil and gas production*

API Spec 11B, *Specification for Sucker Rods*¹⁾

ASTM D412-06ae2, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers — Tension*²⁾

ASTM D471, *Standard Test Method for Rubber Property — Effect of Liquids*

ASTM D429-08, *Standard Test Methods for Rubber Property — Adhesion to Rigid Substrates*

ASTM D575, *Standard Test Methods for Rubber Properties in Compression*

ASTM D611-07, *Standard Test Methods for Aniline Point and Mixed Aniline Point of Petroleum Products and Hydrocarbon Solvents*

ASTM D623, *Standard Test Methods for Rubber Property — Heat Generation and Flexing Fatigue in Compression*

ASTM D624, *Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers*

ASTM D2240-05, *Standard Test Method for Rubber Property — Durometer Hardness*

3 Terms and definitions

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

NOTE For quality system related terms used in this document and not defined below, reference can be made to ISO 9000.

3.1

actual capacity per rpm

volumetric capability determined through functional testing for a specific product

NOTE “rpm” has been retained in this term on the basis that it is part of an established industry terminology. However, it is deprecated by ISO as a unit, in which case it is rendered as the accepted form “r/min.”

3.2

applied torque

torque that is applied to the top of the drive string by the surface drive system

3.3

artificial lift system

assembly of equipment used to transport fluid from a subsurface formation to surface, which may include pump, drive string, prime mover and production tubing

3.4

auxiliary equipment

equipment or components that are outside the scope of this part of ISO 15136 and that are typically selected and/or installed by the user/purchaser

1) American Petroleum Institute, 1220 L Street North West, Washington, DC 20005, USA.

2) American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA.

EXAMPLES Tag bars, gas separators and torque anchors.

3.5

bottom-drive system

PCP drive system utilizing a downhole prime mover

3.6

casing

pipe extending from the surface and intended to line the walls of a drilled well

3.7

casing size

nominal casing OD as specified in ISO 11960

3.8

core deflection

radial offset of the stator cavity centre-line from the stator tube centre-line

3.9

corrosive environment

operating environment where the combination of temperature and chemical agents causes degradation of the equipment

3.10

design validation

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

3.11

design verification

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

3.12

dogleg severity

localized wellbore curvature

3.13

differential pressure

difference between pump intake and discharge pressures

3.14

downhole capacity per rpm

volumetric capability estimated through calculations and downhole conditions

NOTE "rpm" has been retained in this term on the basis that it is part of an established industry terminology. However, it is deprecated by ISO as a unit, in which case it is rendered as the accepted form "r/min."

3.15

drive string

device transmitting power (usually sucker rods) between the surface drive system and the PCP

3.16

engaged cavities

number of full cavities created by the interaction between the rotor and stator

3.17

failed item

any item that has failed

3.18

failure

termination of the ability of an item to perform a required function

3.19

failure descriptor

apparent, observed effect of failure (of a failed item)

3.20

failure cause

circumstances during design, manufacture, or use which have led to a failure

3.21

flow rate

volume of fluid pumped per unit of time

3.22

friction torque

resistance to rotation of the drive string (inside the tubing) and the rotor (inside the stator) that is dependent upon factors including (but not exclusive to) well depth and trajectory, pump geometry and interference fit between rotor and stator, and stuffing box characteristics

3.23

function

operation of a product during service

3.24

functional specification

features, characteristics, process conditions, boundaries and exclusions defining the performance and use requirements of the equipment

3.25

functional test

test performed to confirm proper equipment operation

3.26

grade

category or rank given to different requirements for quality or design validation

3.27

head rating

pressure rating expressed in terms of equivalent water column

3.28

hydraulic torque

torque induced by the differential pressure across the pump

3.29

insertable pump

PCP where the stator is run into the well through the production tubing

3.30

item

any part, component, device, subsystem, functional unit, equipment or system that may be individually considered

3.31

manufacturing

process and action performed by an equipment supplier/manufacture that are necessary to provide finished component(s), assembly(ies) and related documentation, that fulfil the requests of the user/purchaser and meet the standards of the supplier/manufacture

NOTE Manufacturing begins when the supplier/manufacture receives the order and is completed at the moment the component(s), assembly(ies) and related documentation are surrendered to a transportation provider.

3.32

maximum operating speed

maximum operating speed for the pump as specified by the supplier/manufacture

3.33

maximum operating temperature

maximum operating temperature for the pump as specified by the supplier/manufacture

3.34

model

equipment with unique components and operating characteristics which differentiate it from other equipment of the same type

3.35

no-turn tool

prevents the PCP stator and/or tubing from backing off due to rotational torque caused by the interference fit between the rotor and stator

3.36

nominal capacity per rpm

published volumetric capability based on theoretical calculations and adjusted for commercial purposes

NOTE "rpm" has been retained in this term on the basis that it is part of an established industry terminology. However, it is deprecated by ISO as a unit, in which case it is rendered as the accepted form "r/min."

3.37

non-conformance

non-fulfilment of a specified requirement, such as the divergence of equipment, part, practice or procedure from an established standard

3.38

operator

user of the equipment

3.39

operator's manual

publication issued by the supplier/manufacture that contains detailed data and instructions related to the design, installation, operation and maintenance of equipment

3.40

operating environment

set of conditions to which the product is exposed during its full life cycle

3.41

orbit tube

section of oversized production tubing installed immediately above the stator

3.42

PCP geometry

unique combination of pitch, eccentricity and diameter

3.43

performance ratings

ratings for the hydraulic performance of the pump

3.44

pressure rating

rated differential pressure capacity

3.45

primary failed item

failed item within the PCP responsible for initiating the failure of the PCP

3.46

prime mover

motor (typically hydraulic, electric or internal combustion) providing the torque to rotate the pump rotor

3.47

progressing cavity pump

PCP

pump installed in a well consisting of a stator and rotor whose geometry of assembly is such that it creates two or more series of lenticular, spiral, separated cavities

3.48

qualified part

part manufactured under an authorized quality assurance programme and in the case of replacement, produced to meet or exceed the performance of the original part

3.49

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

3.50

reason for pull

motive for the pump being pulled from the well

3.51

redress

any activity restricted to the replacement of qualified parts

3.52

repair

any activity beyond the scope of redress that includes disassembly, re-assembly and testing with or without the replacement of qualified parts and may include machining, welding, heat treating or other manufacturing operations that restore the equipment to its original performance

3.53

required function

function or a combination of functions of an item, which is considered necessary to provide a given service

3.54

rotor

helical, contoured shaft

3.55

rotor phasing alignment jig

short segment of material moulded to match the rotor profile

3.56

substantial design change

change to the design, identified by the supplier/manufacturer, that affects the performance of the product in the intended service condition

3.57

size

relevant dimensional characteristics of the equipment as defined by the supplier/manufacturer

3.58

slugging

well production characterized by non-homogeneous flow

3.59

stator

segment of tube with an internal helical contoured surface which meshes with a rotor to create a series of lenticular cavities along the length of the tube

3.60

stator phasing alignment jig

short segment of material moulded to match the stator core profile

3.61

swelling process

volume increase of an elastomer when a fluid diffuses into the material due to physical interactions between fluid and the elastomer

3.62

tag bar

assembly attached to the bottom of the stator that limits the distance the rotor may extend past the end of the stator

NOTE Also known as a "stop bushing."

3.63

technical specification

requirements that shall be fulfilled by the equipment to comply with the functional specification

3.64

test pressure

pressure at which the equipment is tested based upon all relevant design criteria

3.65

test temperature

temperature at which the equipment is tested based upon all relevant design criteria

3.66

torque anchor

device that prevents the PCP stator and/or tubing from backing off due to rotational torque caused by the interference fit between the rotor and stator and that prevents axial movement of the pump relative to the well casing/liner

3.67

tubing

pipe placed within a well to serve as a production or injection conduit

3.68

tubing deployed

PCP system for which the stator is run into the well on the bottom of the tubing string

3.69

type

equipment with unique characteristics that differentiate it from other functionally similar equipment

3.70

unique identifier

unique combination of alphanumeric characters to identify a specific component

3.71

validated capacity per rpm

volumetric capability determined through design validation testing

NOTE "rpm" has been retained in this term on the basis that it is part of an established industry terminology. However, it is deprecated by ISO as a unit, in which case it is rendered as the accepted form "r/min."

3.72

wellhead

composite of equipment used at the surface to maintain control of the well

NOTE Included in the wellhead equipment are casing heads (lowermost and intermediate), tubing heads, Christmas tree equipment with valves and fittings, casing and tubing hangers, and associated equipment.

4 Abbreviated terms and symbols

4.1 For the purposes of this part of ISO 15136, the following abbreviated terms apply.

- BHT bottomhole temperature
- C30+ hydrocarbon fractions with more than 30 carbon atoms per molecule
- CP failure in the cover cement-prime cement (interfacial failure)
- d day (unit of time)
- GOR gas oil ratio
- M failure in the prime cement-metal interface (interfacial failure)
- MD measured depth
- NDE non-destructive examination
- NPSH net positive suction head
- PCP progressing cavity pump
- PIP pump intake pressure
- R failure of the rubber (substrate failure)
- RC failure in the rubber-cover cement (interfacial failure)
- rpm revolutions per minute
- TVD true vertical depth

4.2 For the purposes of this part of ISO 15136, the following symbols are used.

d_r	drive string diameter
Δp	differential pressure
D	minor diameter
e	eccentricity
F_r	drive string axial load
F_t	axial force on threads
F_s	axial force on torque shoulder
P	stator pitch; see Figure G.1
E_{all}	overall pump efficiency
Q	flow rate at a given differential pressure
Q_{eff}	volumetric efficiency
$Q_{\Delta p}$	volumetric flow rate at a differential pressure
Q_o	volumetric flow rate at $\Delta p < 350$ kPa
q_{TC}	theoretical capacity; see Equation (G.1)
T_r	drive string torque
T_s	torsion on torque shoulder
T_t	torsion on threads
$\dot{W}_{\text{eff}}$	mechanical pump efficiency at specified pressure and flow rate
$\dot{W}_{\text{fluid}}$	fluid power
$\dot{W}_{\text{shaft}}$	input power at the pump shaft
δ	phase or loss angle
σ_e	effective stress
τ	shaft torque
ω	shaft speed

5 Functional specification

5.1 General

The user/purchaser shall prepare a functional specification to order products that conform to this part of ISO 15136 and specify the following requirements and operating conditions as appropriate and/or identify the supplier/manufacturer's specific product. This information is used by the supplier/manufacturer to recommend the PCP and/or components for the application. These requirements and operating conditions may be conveyed by means of a user/purchaser functional-specification form (Annex H) and operational guidelines (Annex F). The user/purchaser shall specify the units of measurement for the data provided.

PCPs are designed for specific applications; their use in new/different applications requires a detailed evaluation by the user/purchaser to ensure that the system can operate properly in all aspects in that new application. Annexes E and F contain installation and operational guidelines that can be relevant in this consideration. The process used to evaluate the new application shall be no less stringent than that required for the initial application.

5.2 PCP type description

The user/purchaser shall select a PCP on the basis of the following conditions:

- a) production requirements;
- b) fluid characteristics;
- c) surface equipment configuration;
- d) stator conveyance method, such as drive string, tubing, wireline, coiled tubing.

5.3 Functional requirements

5.3.1 Application parameters

5.3.1.1 General

While installed, the PCP 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 5.3.1.2 to 5.3.3.4, as applicable.

5.3.1.2 Well information

The following well information shall be specified, as applicable:

- a) operating environment, such as thermal recovery, abrasive conditions, corrosive environments, heavy and conventional oil production, and coal bed methane applications;
- b) well type, such as vertical, slant, deviated or horizontal;
- c) well directional survey, as applicable;
- d) wellhead location, such as onshore, platform or subsea;
- e) reservoir type, such as carbonate, consolidated sandstone, unconsolidated sandstone, coal, or shale;
- f) reservoir recovery mechanism or process, such as aquifer drive, solution-gas drive, water flood, thermal, coal dewatering, enhanced oil recovery, such as CO₂ flood, water-alternating-gas, or polymer flood;

- g) completion type, such as perforated casing, open hole, slotted liner, gravel pack, or sand screen;
- h) previous production history using PCPs and other operating practices, such as other artificial lift methods and flowing well;
- i) service-life expectation, such as total production volume, revolutions, days, years.

5.3.1.3 Completion information

The following completion information shall be specified, as applicable:

- a) pump setting depth in terms of MD and TVD of the pump intake;
- b) depth of producing interval in terms of MD and TVD;
- c) current well total depth, such as plug-back depth in terms of MD and TVD;
- d) in cases where no well deviation survey is provided:
 - inclination (hole angle) and wellbore curvature (if applicable) at pump seating depth,
 - maximum wellbore curvature (maximum dogleg severity) between wellhead and pump seating depth through which it is necessary for the PCP to pass through during installation;
- e) casing size, including outside diameter and mass (weight), connection type and grade of production casing;
- f) minimum drift diameter between wellhead and pump seating depth;
- g) minimum drift diameter at pump seating depth;
- h) production tubing size, including outside diameter, mass (weight), connection type and grade;
- i) production tubing inner coating type and thickness;
- j) pump intake type preference, such as slotted, selective, static gas separator, tail joint;
- k) torque anchor type;
- l) measured depth to the top of the torque anchor;
- m) other well dimensions that can restrict pump installation or operation.

5.3.1.4 Operating and production information

The following operating and production information shall be specified, as applicable:

- a) total liquid rate at standard conditions (15 °C, atmospheric pressure);
- b) water cut by percentage volume of produced liquids or producing oil and water rates;
- c) sand cut, expressed as percent by volume;
- d) maximum and minimum operational speed, expressed in revolution per minute;
- e) wellhead pressure;
- f) wellhead fluid temperature;

- g) casing-head pressure;
- h) static or shut-in pressure at the pump intake;
- i) static or shut-in reservoir pressure at a reference depth;
- j) static or shut-in temperature at the pump intake;
- k) static or shut-in reservoir temperature at a reference depth;
- l) producing gas-oil ratio or measured gas rate at standard conditions (15 °C, atmospheric pressure);
- m) ratio of casing-gas rate to tubing-gas rate at standard conditions (15 °C, atmospheric pressure) and/or downhole free-gas-separation efficiency;
- n) PIP, expressed as one of the following:
 - producing pressure at the pump intake,
 - producing fluid level (metres to fluid), annular gradient/density and casing-head pressure,
 - reservoir static pressure and productivity index,
 - static fluid level and productivity index;
- o) slugging tendency, such as gas, water, solids, steam.

5.3.2 Environmental compatibility

The user/purchaser shall specify the environmental compatibility requirements. The following parameters shall be supplied, as applicable:

- a) for oil:
 - density at standard temperature and pressure (15 °C, atmospheric pressure);
 - compositional analysis, including, but not limited to
 - type and concentration of aromatic species,
 - aniline point;
 - viscosity at test conditions and/or operating conditions;
 - bubble-point pressure at reservoir temperature;
- b) for water:
 - pH;
 - density;
 - chloride concentration;

c) for gas:

- composition, such as
 - CO₂ concentration, expressed as a mole percentage,
 - H₂S concentration, expressed as a mole percentage,
 - steam temperature, pressure and quality;
- specific gravity;

d) for solids:

- history of solids-related problems, such as erosion, plugging, wear;
- morphology, such as size, structure, angularity, composition;
- scale-deposition tendency;
- asphaltene and/or paraffin deposition tendency;

e) other:

- emulsion properties, such as
 - inversion point (percentage water cut),
 - emulsion viscosity at downhole operating conditions over predicted pump life,
 - emulsion forming tendency;
- foamy oil behaviour;
- other fluid types and concentrations, such as diluent, corrosion/scale inhibitor, completion fluid, dispersants and injection points in the wellbore.

5.3.3 Compatibility with related well equipment and services

5.3.3.1 General

The user/purchaser shall specify, where applicable, the interface connection designs and material requirements, and external dimensional limitations, required to assure that the product shall conform to the intended application.

5.3.3.2 Drive system

The following topics shall be considered for the application:

a) type: surface or bottom drive;

NOTE Surface-drive systems are covered in ISO 15136-2.

b) torque, speed and axial load limitations;

c) for bottom-drive systems:

- type of drive, such as electric, hydraulic,
- operational limitations, such as heat generation, flow restriction on intake or discharge,
- maximum outside diameter, length and position, above or below PCP,
- gearbox ratio.

5.3.3.3 Drive string

The following topics shall be considered for the application:

- a) type, such as standard, continuous, hollow;
- b) material grade;
- c) diameter of body;
- d) connection type and description;
- e) torque and axial load rating;
- f) rotating centralizer type, description and number installed;
- g) guide type, description and number installed.

5.3.3.4 Accessory equipment and well operation

The following topics shall be considered for the application:

- a) OD of injection tubing string and injection point, such as above pump, below pump, annulus, tubing string;
- b) subsurface instrumentation OD, length and location, such as above or below pump, as applicable;
- c) subsurface equipment OD, ID, length, location relative to the pump and attachment to the pump, such as interfaces with tag bars, no-turn tools, gas separators, tail pipes, backflow valves;
- d) well intervention limitations, such as minimum polished rod length, pump length, maximum coiled tubing diameter.

5.4 Design validation

The user/purchaser shall specify one of the following three design-validation grades defined by this part of ISO 15136:

- V1: highest level of design validation;
- V2: basic design validation;
- V3: legacy.

The principal requirements for each design validation grade are presented in Annex B.

5.5 Product functional evaluation

The user/purchaser shall specify one of the following two product functional evaluation grades defined by this part of ISO 15136:

- F1: functional hydraulic test of the pump:

The user/purchaser may specify the volumetric efficiency range, test fluid, pump speed, fluid temperature and pressures for use in the functional test.

- F2: functional evaluation without bench testing:

The user/purchaser shall specify the volumetric efficiency range, fluid, pump speed, fluid temperature and pressures as applicable for use in the functional evaluation.

The principal requirements for each product functional evaluation grade are presented in Annex C.

5.6 Quality control grades

The user/purchaser shall specify one of the following three quality control grades defined in Clause 7.

- Q1: highest level of quality control;
- Q2: intermediate level of quality control;
- Q3: basic level of quality control.

5.7 Additional documentation

Additional documentation, such as operator's manuals, certificate of compliance and/or product data sheet, above that required for a specific quality grade may be requested by the user/purchaser.

5.8 Additional requirements

The user/purchaser may specify additional design verification, design validation testing and/or product functional evaluation that is deemed necessary for a specific application. These requirements shall be in addition to those specified in Annexes B and C.

Application-specific elastomer compatibility and bond testing, when requested, shall be performed in accordance with Annex D. These requirements shall be in addition to those specified in Annex A.

6 Technical specification

6.1 General

The supplier/manufacture shall prepare the technical specification that responds to the requirements defined in the functional specification. The supplier/manufacture shall also provide the user/purchaser with the product data defined in Clause 7.

6.2 Technical characteristics

The following criteria shall be met.

- The PCP shall move fluid from downhole to the surface against a differential pressure and shall do so until intentional intervention defines otherwise. Exceptions to this are service-life limitations associated with normal equipment wear or deterioration.
- While installed, the PCP shall perform in accordance with its functional specification.
- Where applicable, the PCP shall be compatible with related well equipment and services.

6.3 Design criteria

6.3.1 Materials

Metallic and non-metallic materials shall be specified by the supplier/manufacturer and shall be appropriate for the requirements in the functional specification. The supplier/manufacturer shall have written specifications for all materials and all materials used shall comply with these specifications.

Materials substitutions in validated equipment designs are allowed without validation testing provided that the supplier/manufacturer's materials-selection criteria are documented and approved by a qualified person and meet all other requirements of this part of ISO 15136.

6.3.2 Metals

6.3.2.1 General

In a PCP, the primary metal components are the stator tube and associated connecting assemblies and the rotor, which is normally coated or plated.

The supplier/manufacturer's specifications shall define the materials for the stator tube and rotor bar that are appropriate for the application, taking into account the following:

- a) chemical-composition limits;
- b) mechanical-property limits:
 - tensile strength,
 - yield strength,
 - elongation,
 - hardness.

The rotor bar shall be of sufficient strength that the profile and connection can withstand the combined torsional and axial loads within the specified operational range for the pump model. When bending loads and alternating combined loads are anticipated, the rotor-strength evaluation shall consider the effect of fatigue. High-temperature applications shall also de-rate material strength as appropriate for the application. The resulting design verification shall be approved by a qualified person.

Material test reports provided by the material supplier or the manufacturer may be used to verify compliance of the material to the specifications.

6.3.2.2 Welds

Welds in rotor and stator components shall be in accordance with the supplier/manufacturer's specifications as defined in 7.6.3. Weld identification and examination shall be in accordance with the specified quality grade.

6.3.3 Rotor coating or surface treatments

Rotor coating or surface-treatment type and thickness (if applicable) shall take into consideration the fluid characteristics of the operating environment specified in the functional requirements, in particular the abrasiveness, as well as any special chemical treatments that are anticipated. The supplier/manufacturer's specifications shall define the characteristics and acceptance criteria of the rotor coating or treatment, including

- a) the basic coating or surface treatment composition;
- b) the effective surface hardness;
- c) the minimum and maximum coating thickness on rotor peak and valley, if applicable;
- d) the surface roughness.

6.3.4 Stator elastomer and bond system

The stator elastomer and bond system shall comply with Annex A, which contains detailed information on elastomer classifications, characteristics and test procedures.

The supplier/manufacturer shall have documented procedures and evaluations, the results of which shall verify that the stator elastomer material and bond system used are suitable for use in the specific PCP configuration, environment and application as defined in the functional specification. These evaluations shall be performed and the results approved by a qualified person and shall consider test data and the historical performance of the elastomer and bond system in combinations of pressure, temperature and fluids similar to those in the functional specification.

6.4 Dimensional information

6.4.1 Rotor-stator fit

The supplier/manufacturer shall have documented procedures performed by qualified personnel to select the appropriate rotor-stator fit to meet the requirements of the functional specification. Annex G provides information on considerations for selecting rotor-stator fit.

6.4.2 Dimensional limits

PCP components shall be dimensioned such that they can be run through and, where required, operated in the specified well curvatures. For tubing-deployed configurations, the stator shall provide adequate annular space for gas separation and, in instances where the PCP is landed below the perforations, provide for fluid passage without excessive pressure drops. In the event that the functional specification includes equipment such as secondary tubing strings for injection/flushing or instrumentation cables, the stator assembly shall allow the required annular space.

The supplier/manufacturer shall specify the following:

- a) stator OD and maximum OD of the stator assembly; the stator assembly shall pass through the casing for a tubing-deployed pump and through the tubing for insertable pumps and all other devices that are part of these strings;

- b) major diameter of the rotor and maximum diameter of the rotor assembly; the rotor assembly shall pass through the production tubing and all other devices that are part of the tubing string;
- c) orbit diameter of the rotor profile and rotor connection; the eccentric motion of the rotor and the rotor connection shall be less than the inside diameter of the production tubing or orbit tube immediately above the stator;
- d) total assembly lengths and masses (weights) of the rotor and stator.

6.5 Performance ratings

6.5.1 Volume capability

The supplier/manufacture shall provide the nominal capacity per rpm and validated capacity per rpm for each basic pump geometry. These parameters shall be expressed in terms of a fluid rate at a given speed as $(\text{m}^3/\text{d})/(100 \text{ r/min})$.

The validated capacity per rpm shall be determined through validation testing as outlined in 6.7 and detailed in Annex B. Additional discussion on volume capability is provided in Annex G.

6.5.2 Pressure and head rating

The supplier/manufacture shall provide the PCP pressure rating, head rating, pressure per cavity and number of engaged cavities.

Pressure ratings shall be confirmed through validation testing as outlined in 6.7 and detailed in Annex B. Additional discussion on pressure rating is provided in G.5.

6.5.3 Design performance curves

The supplier/manufacture shall prepare the design performance curves for each model that displays fluid rates as a function of differential pressure and pump speed. At a minimum, these curves shall present calculated data from zero pressure to the pump pressure rating, at speeds of 100 r/min, 200 r/min and 300 r/min with a nominal rotor and stator fit.

6.5.4 Volumetric efficiency

The supplier/manufacture shall prepare design performance curves representing predicted performance under conditions specified in the functional specification.

NOTE Actual volumetric efficiencies can vary significantly over the wide range of potential downhole and operating conditions. Volumetric efficiency represents a combination of the pump volumetric efficiency and the inefficiency implied by the differences between the multiphase fluid rate at the pump intake and the surface liquid rate. See Annex G for more information.

6.5.5 Design pump speed, torque and power

The supplier/manufacture shall prepare the design hydraulic and total torque and power values for the PCP design as a function of differential pressure and speed. Where appropriate, the supplier/manufacture shall specify maximum torque and minimum and maximum rotational speed values.

NOTE Additional discussion on pump speed, torque and speed is provided in Annex G. It is necessary that the design hydraulic and total torque and power values be used cautiously since they might not be representative of downhole conditions. Experience is used to translate these values to expected performance under downhole conditions.

6.5.6 Maximum pump intake gas volume fraction

The supplier/manufacturer shall provide the maximum pump intake gas volume fraction that can be handled by the pump. The supplier/manufacturer shall have a documented process that supports the reported maximum pump-intake gas-volume fraction.

NOTE While PCPs are capable of pumping gas, it results in non-uniform pressure loading within the pump and a reduced ability to remove internal frictional heat. The resulting mechanical loads and temperatures within the pump can have a detrimental impact on pump service life.

6.6 Design verification

Design verification shall be performed by the supplier/manufacturer to verify that the product design meets the technical specifications. Design verification includes documented activities such as review of design calculations, product testing and comparison with similar designs and historical records of defined operating conditions. Empirical methods and/or physical testing used in design verification shall be fully documented and supported with drawings and material specifications.

The results of design verification shall be documented and include a review of the fundamental geometry and its ability to meet the volume and pressure capacity requirements, dimensional limits, strength characteristics and tolerances to ensure that it meets the technical specifications. All design verification documentation shall be included in the product design file and be approved by a qualified person other than the design's originator.

6.7 Design validation

Design validation testing shall be performed on each PCP basic design of rotor/stator and elastomer combination to ensure that its design meets the supplier/manufacturer's technical specifications. The design validation grade specifies the design validation process(es), procedure(s) and test(s) required for each validation grade. Annex B provides a detailed description of the three validation grades (V1, V2 and V3) in this part of ISO 15136. Supplemental design validation may be required by the user/purchaser.

NOTE Some applications can require supplemental design validation testing. Examples include pump performance or durability testing with alternative test media and multiphase fluids; minimum pump intake pressure; maximum gas fraction; or advanced elastomer evaluation, such as explosive decompression resistance, compression set, heat resistance, dynamic characterization or H₂S resistance.

6.8 Functional evaluation requirements

Functional evaluation shall be performed in accordance with Annex C and approved by a qualified person to verify that each PCP manufactured meets the supplier/manufacturer's documented requirements, technical specification and the functional specification. The results of these evaluations shall be recorded and become a portion of the quality documentation for that product.

6.9 Allowable design changes

All design changes shall be documented and reviewed by the supplier/manufacturer against the design verification and design validation documents to determine if the change is a substantial change. A substantial design change is a change to the design identified by the supplier/manufacturer that affects the performance of the product in the intended service condition. A design that undergoes a substantial change becomes a new design, requiring design verification in accordance with 6.6 and design validation in accordance with 6.7.

All design changes and modifications shall be identified, documented, reviewed and approved before their implementation and meet the applicable validation test requirements of this part of ISO 15136. Justifications for design changes that are identified as non-substantial shall be documented. The supplier/manufacturer shall, at a minimum, consider the following for each design change:

- a) stress levels in the modified or changed components;

- b) material changes;
- c) functional changes.

6.10 Scaling of design validation

Scaling may be used to validate new designs and design variations based on previously validated designs with the following limitations.

- a) Scaling applies only to designs validated to V1 or V2.
- b) Elastomer and bond validation in accordance with Annex A shall apply only to the specific elastomer compound tested. Scaling of this validation is not allowed for other elastomer compounds. Scaling of this validation is allowed for any designs that utilize the tested elastomer compound.
- c) Durability validation in accordance with Annex B can be scaled to design variations, including elastomer compounds that utilize the same stator geometry as the tested product, as long as the elastomer compound used in the design variation has been previously validated in a durability test on any stator geometry.
- d) Hydraulic validation in accordance with Annex B shall apply only to the specific elastomer compound and stator geometry combination tested. Hydraulic validation may be scaled to any design variations that utilize the same elastomer compound and stator geometry as the tested product.

7 Supplier/manufacturer requirements

7.1 General

The detailed requirements to verify that each product manufactured meets the requirements of the functional and technical specifications for each specific product are contained in Clause 7.

7.2 Documentation and data control

7.2.1 General

The supplier/manufacturer shall establish and maintain documented procedures to control all documents and data that relate to the requirements of this part of ISO 15136. These documents and data shall be maintained to demonstrate conformance to specified requirements. All documents and data shall be legible and shall be sorted and retained in such a way that they are readily retrievable in facilities that provide suitable environments to prevent damage or deterioration and to prevent loss.

Documents and data may be in any type of media, such as hard copy or electronic media. All documents and data shall be available and auditable by the user/purchaser. Design documents and data shall be maintained for five years after date of last manufacture of that product.

7.2.2 Design documentation

Documentation of the design process for each type, size and model of pump shall include the following as a minimum:

- a) design criteria;
- b) functional and technical specifications;
- c) engineering drawings and bill of materials;
- d) applicable specifications and standards;

- e) validation testing procedures, acceptance criteria and approved results;
- f) functional evaluation procedures and acceptance criteria;
- g) design changes and design change justifications, if applicable.

7.2.3 Delivery documentation

Documentation supplied at the time of delivery of a product to the user/purchaser shall include the following as a minimum:

- a) name and address of supplier/manufacturer;
- b) supplier/manufacturer product identification;
- c) functional evaluation documentation according to specified functional grade;
- d) quality documentation according to specified quality grade.

7.2.4 Operator's manual

When required by the quality grade or the user/purchaser, an operator's manual shall be supplied and shall contain the following information as a minimum:

- a) name and address of supplier/manufacturer;
- b) supplier/manufacturer product identification;
- c) representative illustration(s) identifying major components, significant dimensions and configurations and details of the interface connections;
- d) handling and storage guidelines;
- e) pre-installation inspection and pre-service procedures;
- f) installation guidelines, including make-up procedures for all pump components and rotor space-out (see Annex E);
- g) operating and troubleshooting guidelines, including precautions for safe and environmentally acceptable operation.

7.2.5 Certificate of compliance

When required by the quality grade or the user/purchaser, certificates of compliance shall be supplied and shall state that the product meets the following requirements, as a minimum:

- a) quality grade;
- b) functional grade;
- c) validation grade.

The statement shall include the product identification and shall be approved by the supplier/manufacturer's designated qualified person.

7.2.6 Product data sheet

When required by the quality grade or the user/purchaser, a product data sheet shall be supplied and shall contain the following, as a minimum:

- a) product identification;
- b) name and address of supplier/manufacturer;
- c) conveyance method;
- d) nominal capacity per rpm;
- e) validated capacity per rpm;
- f) pressure rating;
- g) pressure per cavity;
- h) number of engaged cavities;
- i) design performance curves;
- j) torque and power curves;
- k) maximum pump-intake free-gas volume fraction;
- l) minimum and maximum speed;
- m) rotor length and mass (weight);
- n) stator assembly length and mass (weight);
- o) rotor major, minor and orbit diameter;
- p) stator outside diameter and maximum outside diameter of stator assembly;
- q) end connections for rotor and stator;
- r) rotor coating type and thickness;
- s) operator's manual identification.

7.2.7 Elastomer data sheet

When required by the quality grade or the user/purchaser, an elastomer data sheet shall be provided and shall contain, as a minimum, the following items as defined in Annex A:

- a) stator elastomer classification;
- b) fluid resistance;
- c) mechanical properties;
- d) maximum operating temperature;
- e) unaged bond properties.

7.3 Product identification

Each furnished rotor and stator shall be permanently identified according to the supplier/manufacturer's specifications, which shall include the type and method of application. The following information is the minimum that shall be marked on each product: