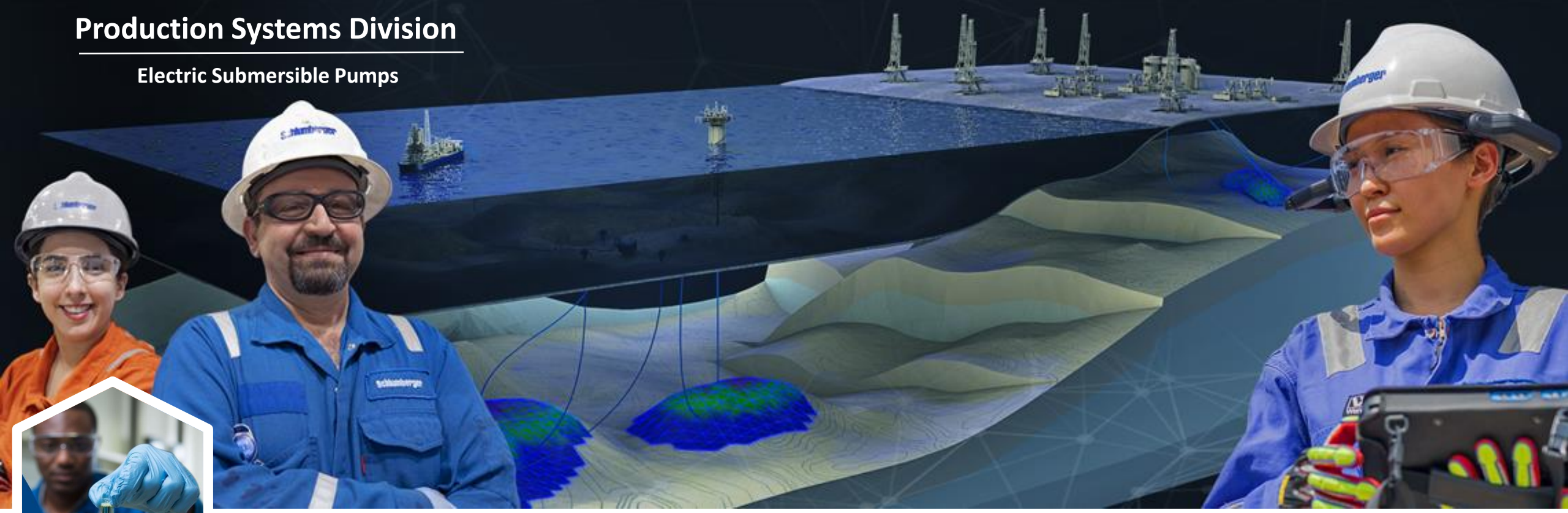
Production Systems Division

Electric Submersible Pumps



A world first: Installation of an ISO 15551-1 compliant ESP

Max Bilfinger *MEng*, Artificial Lift Project Engineer

EuALF - 12th February 2021

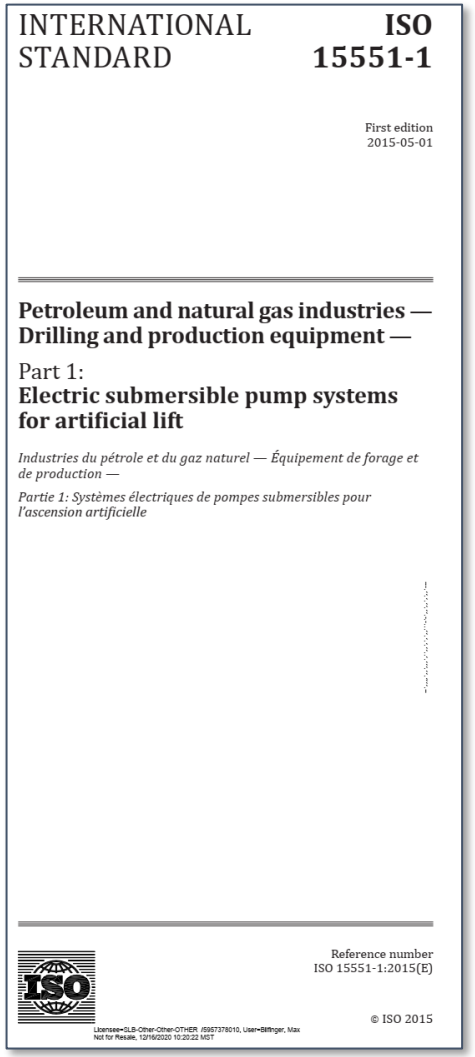
Schlumberger

Agenda

- ISO 15551-1: A Brief Summary
- Scope of Work & Technical Requirements
- Equipment Selection & ISO Qualification
- Field Deployment
- Operation

ISO 15551-1: A Brief Summary

- **International standard for tubing deployed ESP systems covering …**
  - discharge heads
  - centrifugal pumps (including gas handlers)
  - intake systems (including gas separators)
  - protectors
  - induction motors
  - shaft couplings
  - power cable, motor lead extension & potheads
- **Providing minimum requirements for …**
  - design, design verification and validation
  - manufacturing and data control
  - performance ratings
  - functional evaluations
  - handling and storage
- **These requirements are defined by a tier-based system:**
  - Design validation grades: **V1, V2**
  - Functional evaluations grades: **F1, F2, F3**
  - Quality control grades: **Q1, Q2, Q3**


INTERNATIONAL STANDARD

ISO 15551-1

First edition
2015-05-01

Petroleum and natural gas industries — Drilling and production equipment —

Part 1:
Electric submersible pump systems for artificial lift

Industries du pétrole et du gaz naturel — Équipement de forage et de production —

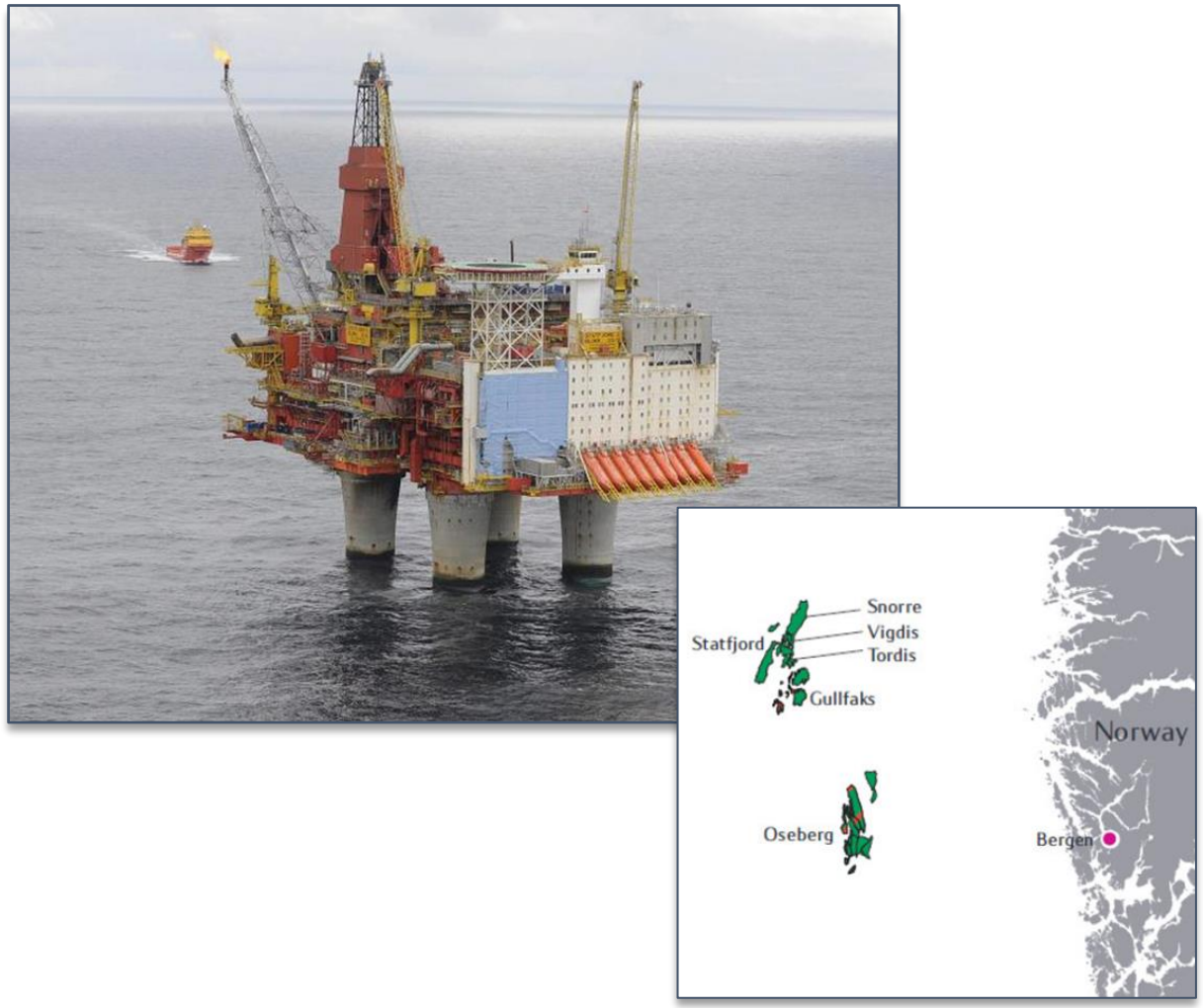
Partie 1: Systèmes électriques de pompes submersibles pour l'ascension artificielle

Reference number
ISO 15551-1:2015(E)

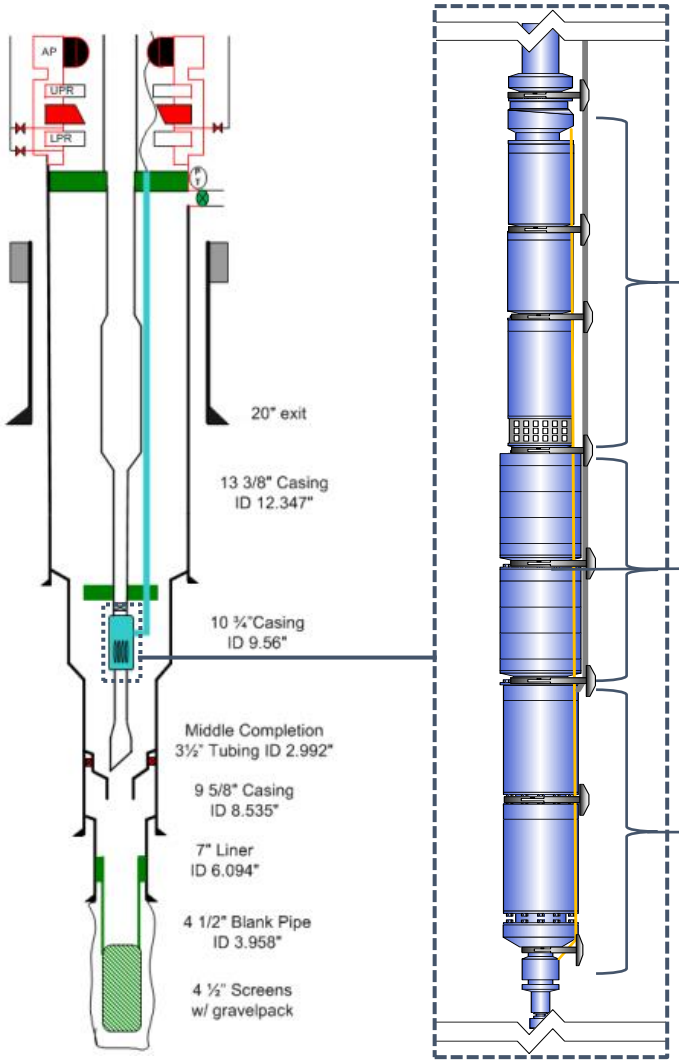
Scope of Work & Technical Requirements

- Late life de-watering
- Equipment to comply with **ISO 15551-1**

  V2:F2:Q2
- 6 ESP wells
- Operating rates up to 4000 m^3/d
- Power requirements up to 1300 HP



Equipment Selection



Pump

562 Series, H22500, 123 Stages

- Compression construction
- Integral intake at bottom pump
- 9Cr1Mo housings with Monel coating
- Ni-Resist stages
- 2205 duplex stainless steel head and base
- Tungsten Carbide bearings
- Inconel 625+ shaft

Protector

738 Series, Tandem LSBPB, Maximus

- 9Cr1Mo housings with Monel coating
- 2205 duplex stainless steel head and base
- Tungsten Carbide bearings
- AFLAS bags and shaft seals
- Inconel 718 shaft

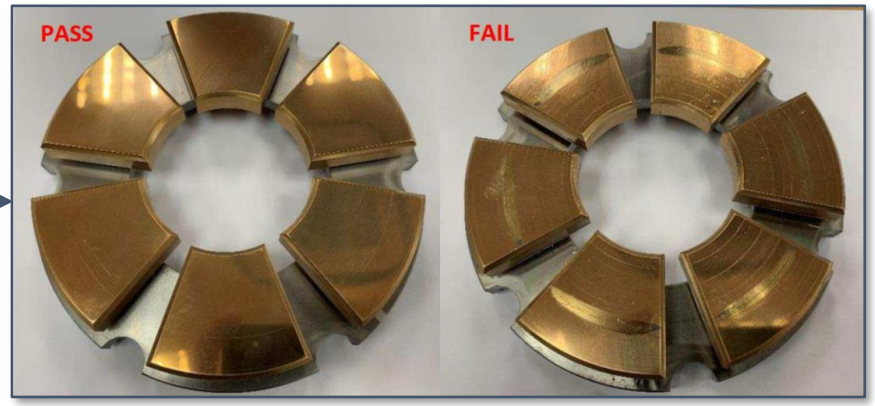
Motor

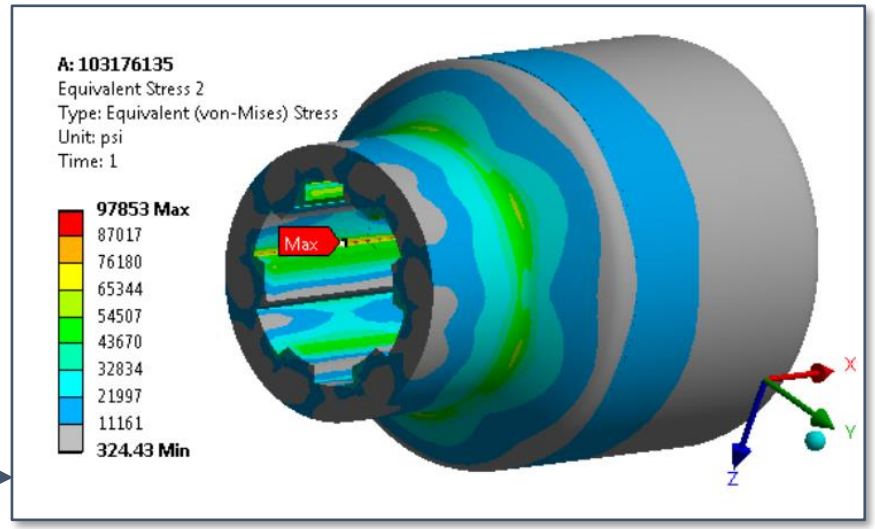
738 Series, Maximus

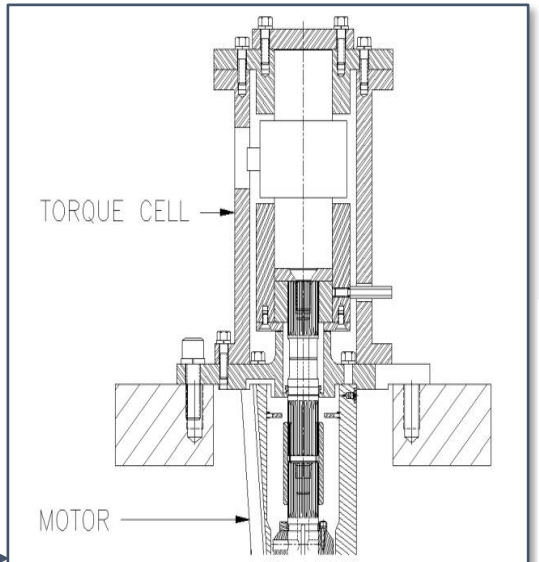
- 1500 HP / 4.5 KV / 200 Amp @ 60Hz
- 9Cr1Mo housings with Monel coating
- 2205 duplex stainless steel head and base
- Trident #1 plug-in pothead
- 4130 stainless steel shaft

Design Validation - V2 Grade

BODH	• Maximum flow capacity rating • Pressure rating	✓ ✓
Pump	• Performance curve (water) • Maximum GVF rating • Pump stage thrust • Housing pressure rating	✓ ✓ ✓ ✓
Protector	• Volume contraction capacity • Thrust bearing capacity • Deviation limits • Minimum speed for thrust bearing • Pressure cycles • Power requirements	✓ ✗ ✓ ✓ ✓ ✓
Motor	• Performance parameters • Voltage for minimum current • Motor temperature limits • Motor locked rotor current	✓ ✓ ✓ ✗
Coupling	• Torque rating	✗







Functional Evaluation - F2 Grade

Pump

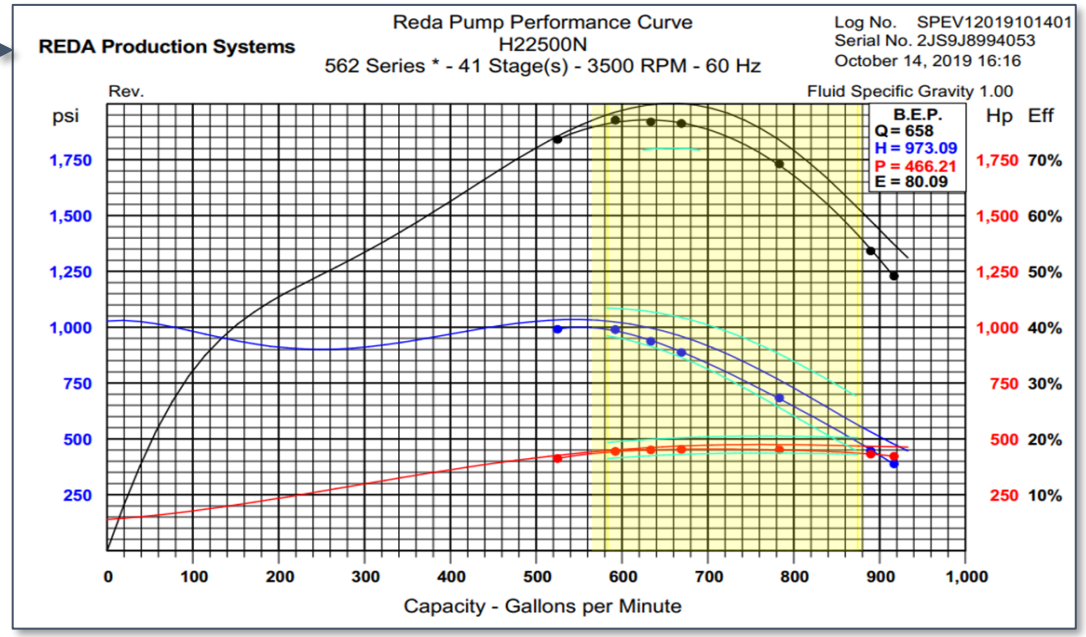
- Hydraulic evaluation ☒
- Shaft settings (extension, end & side play) ☑
- Shaft balancing ☑
- Vibration ☒

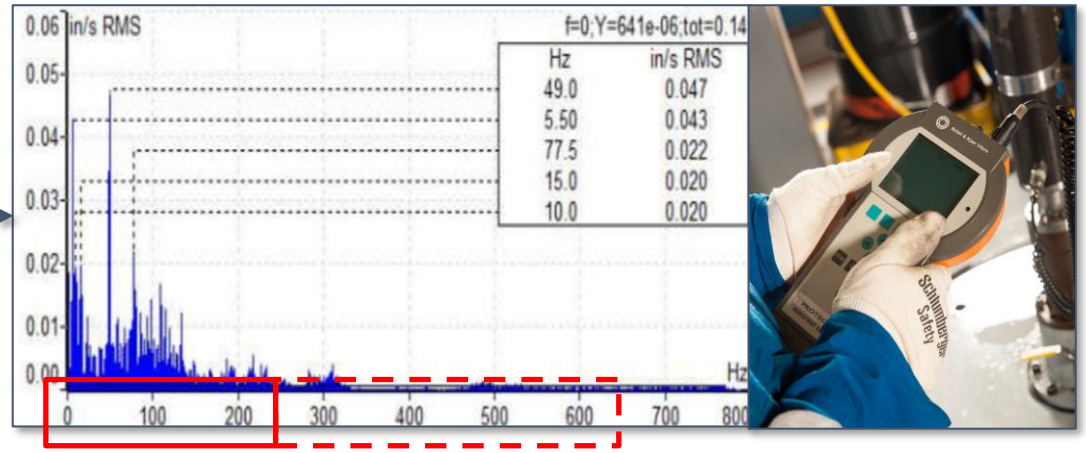
Protector

- Hydrostatic evaluation ☑
- Shaft settings (extension, end & side play) ☑
- Shaft balancing ☑
- Power requirement ☑
- Vibration ☒
- Dielectric strength of oil ☒

Motor

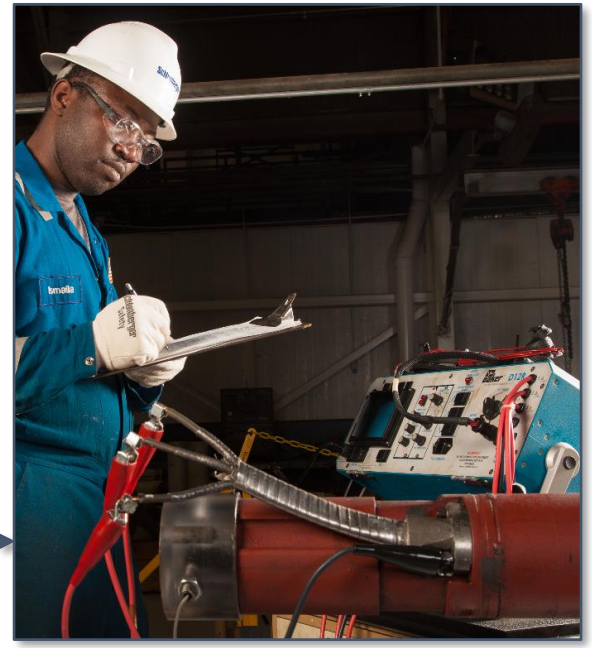
- Hydrostatic evaluation ☑
- Idle current/coast, kW ☑
- Dielectric strength of oil ☒
- Electrical function test ☒
- Vibration ☒





Functional Evaluation - F2 Grade

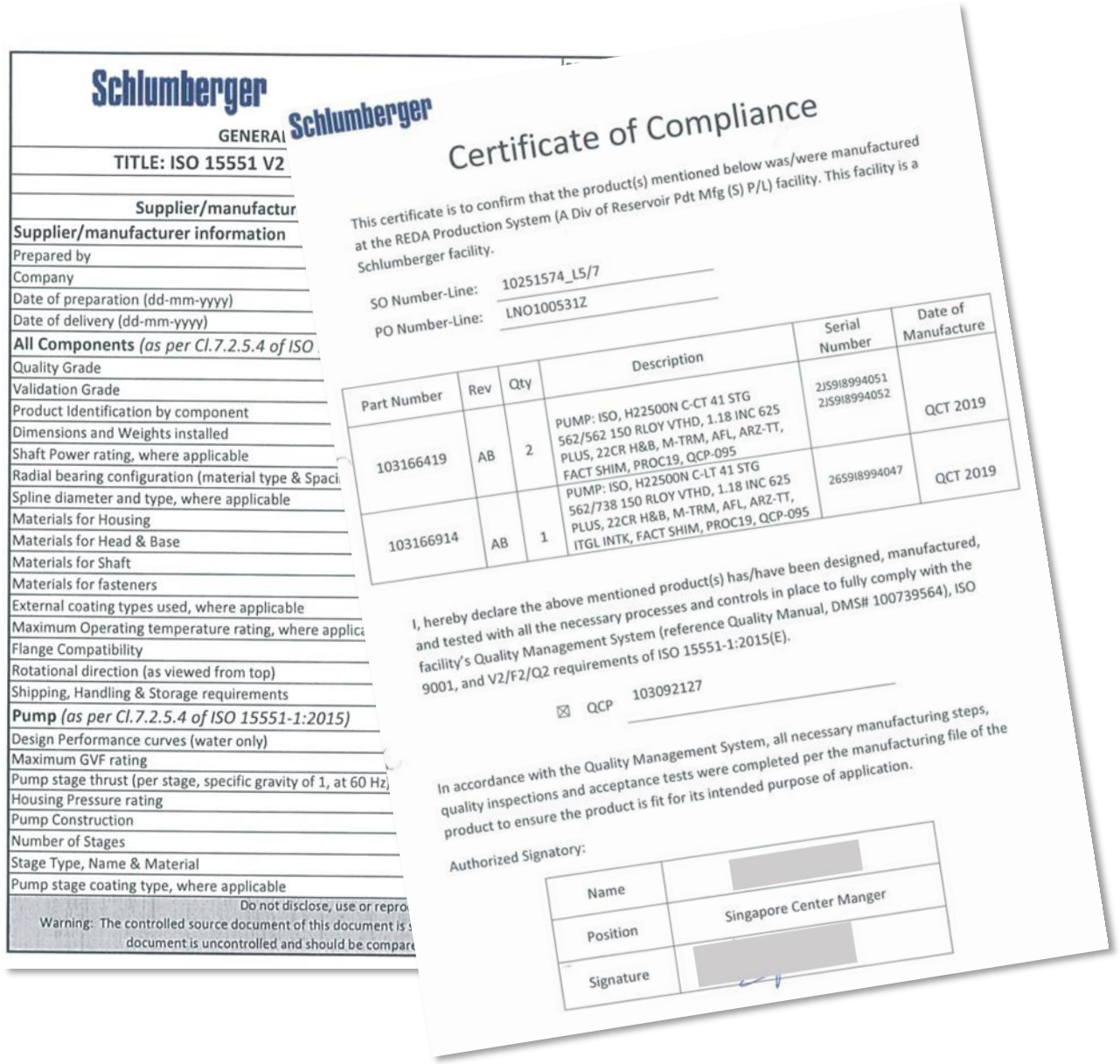
Pump	• Hydraulic evaluation	✗
	• Shaft settings (extension, end & side play)	✓
	• Shaft balancing	✓
	• Vibration	✗
Protector	• Hydrostatic evaluation	✓
	• Shaft settings (extension, end & side play)	✓
	• Shaft balancing	✓
	• Power requirement	✓
	• Vibration	✗
	• Dielectric strength of oil	✗
Motor	• Hydrostatic evaluation	✓
	• Idle current/coast, kW	✓
	• Dielectric strength of oil	✗
	• Electrical function test	✗
	• Vibration	✗



Quality Requirements – Q2 Grade

Equipment

- Documentation ❌
- Raw materials ❌
- Welding ❌
- Brazing ❌
- Dimensional inspection ❌
- Securing of rotor & stator lamination ✅
- Electrical integrity ✅



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GENERAL

TITLE: ISO 15551 V2

Supplier/manufactur

Supplier/manufacturer information
Prepared by
Company
Date of preparation (dd-mm-yyyy)
Date of delivery (dd-mm-yyyy)
All Components *(as per Cl.7.2.5.4 of ISO*
Quality Grade
Validation Grade
Product Identification by component
Dimensions and Weights installed
Shaft Power rating, where applicable
Radial bearing configuration (material type & Spaci
Spline diameter and type, where applicable
Materials for Housing
Materials for Head & Base
Materials for Shaft
Materials for fasteners
External coating types used, where applicable
Maximum Operating temperature rating, where applica
Flange Compatibility
Rotational direction (as viewed from top)
Shipping, Handling & Storage requirements
Pump *(as per Cl.7.2.5.4 of ISO 15551-1:2015)*
Design Performance curves (water only)
Maximum GVF rating
Pump stage thrust (per stage, specific gravity of 1, at 60 Hz)
Housing Pressure rating
Pump Construction
Number of Stages
Stage Type, Name & Material
Pump stage coating type, where applicable

Do not disclose, use or repro

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document is uncontrolled and should be compare

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Certificate of Compliance

This certificate is to confirm that the product(s) mentioned below was/were manufactured at the REDA Production System (A Div of Reservoir Pdt Mfg (S) P/L) facility. This facility is a Schlumberger facility.

SO Number-Line: 10251574_L5/7

PO Number-Line: LNO100531Z

Part Number	Rev	Qty	Description	Serial Number	Date of Manufacture
103166419	AB	2	PUMP: ISO, H22500N C-CT 41 STG 562/562 150 RLOY VTHD, 1.18 INC 625 PLUS, 22CR H&B, M-TRM, AFL, ARZ-TT, FACT SHIM, PROC19, QCP-095	2JS9I8994051 2JS9I8994052	QCT 2019
103166914	AB	1	PUMP: ISO, H22500N C-LT 41 STG 562/738 150 RLOY VTHD, 1.18 INC 625 PLUS, 22CR H&B, M-TRM, AFL, ARZ-TT, ITGL INTK, FACT SHIM, PROC19, QCP-095	26S9I8994047	QCT 2019

I, hereby declare the above mentioned product(s) has/have been designed, manufactured, and tested with all the necessary processes and controls in place to fully comply with the facility's Quality Management System (reference Quality Manual, DMS# 100739564), ISO 9001, and V2/F2/Q2 requirements of ISO 15551-1:2015(E).

☒ QCP 103092127

In accordance with the Quality Management System, all necessary manufacturing steps, quality inspections and acceptance tests were completed per the manufacturing file of the product to ensure the product is fit for its intended purpose of application.

Authorized Signatory:

Name	[redacted]
Position	Singapore Center Manger
Signature	[redacted]

Quality Requirements – Q2 Grade

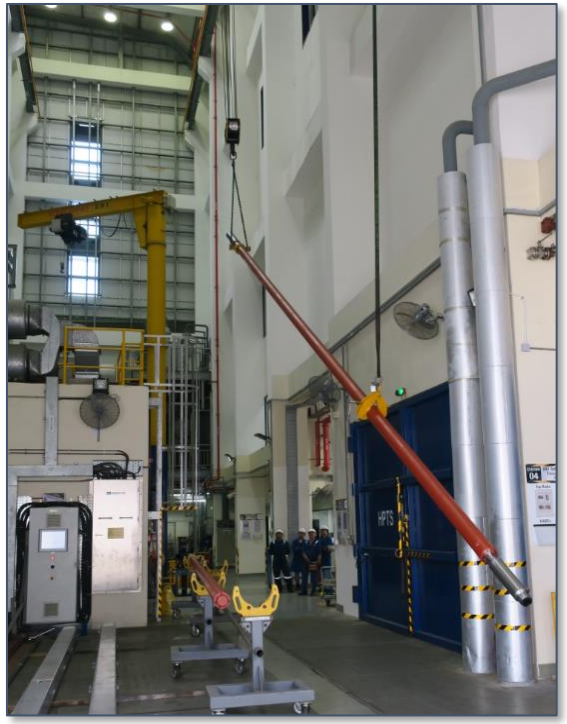
Equipment

- Documentation ✗
- Raw materials ✗
- Welding ✗
- Brazing ✗
- Dimensional inspection ✗
- Securing of rotor & stator lamination ✓
- Electrical integrity ✓

Functional Evaluation of Assembled ESP System

Key Activities

- Deployment of ESP at test facility
- Function test ESP
- Validate pump performance per F2 & V2
- Calculate system efficiency
- 48-channel vibration data recording
- Temperature data recorded throughout ESP
- Pre & post SIT dielectric oil testing



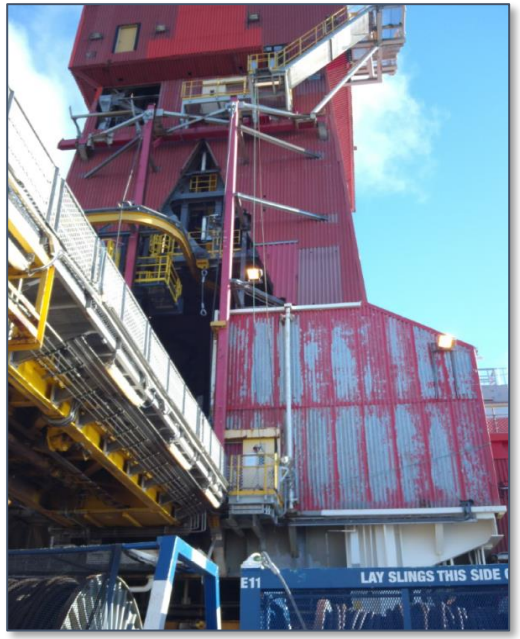
Field Deployment

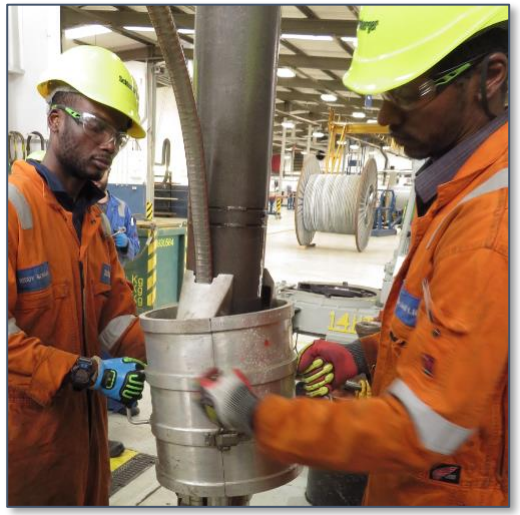
Pre-Mobilisation Checks

- Site visit
- Clamp trial and drift test
- Penetrator interface test

Installation

- Check lists
- Standard work instructions
- Detailed operating procedures (DOPs)





Operation

- Well specific start-up procedures
- 24/7 monitoring of operating parameters
- Weekly reviews of alarm settings
- Regular nodal analysis performed

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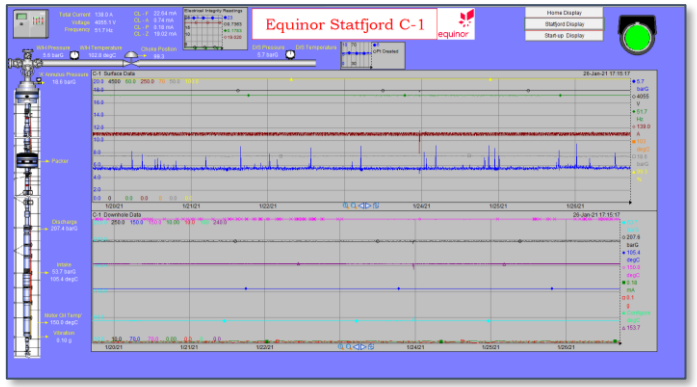
Supplier Name:	Schlumberger Oilfield UK PLC
Equipment Tag/WIN No(s):	N/A
Supplier Document No:	PJ-STA-PR-021
Rev No:	01
Document Title:	**ESP Start-Up procedure for well C35**

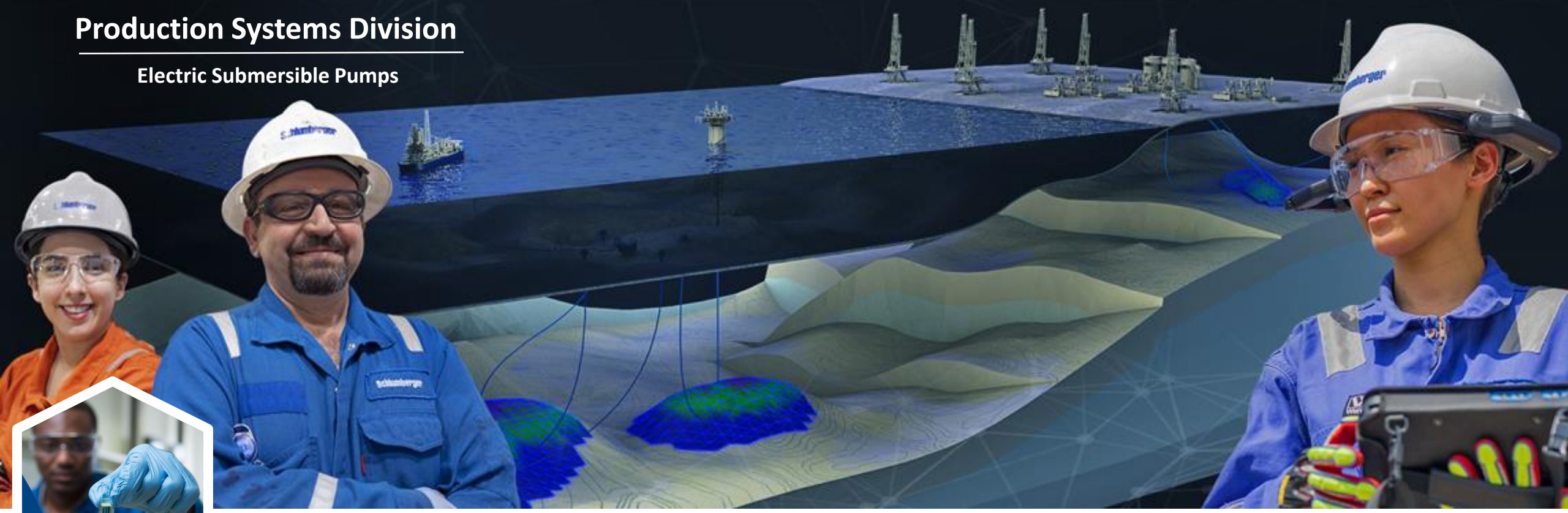
Alternative Document No:

Rev	Description	Date	Orig	Chk'd	App'd
01	Issued for information	30/12/2020	M.B.	-	M.B.

Equinor Approval of Supplier Document:

Code	Description of Code	Signature of Equinor Engineer	Date
A	Accepted - Work May Proceed		
B	Revise and Resubmit - Work May Not Proceed.		
D	Revise and Resubmit - Work May Proceed.		
I	Information Only		





Looking forward to your questions…

Max Bilfinger *MEng*, Artificial Lift Project Engineer
mbilfinger@slb.com

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