Design & Testing of a High-Powered, Live-Well, Cable-Deployable ESP

SpeedDrive 350

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Design & Test of a High-Powered, Live-Well CDESP

- ESP Operations – The Need for Change
- A New ESP Architecture
- Design Considerations & Development Testing
- Full Scale SIT in Test Well
- Q&A

ESP Operations – The Need for Change

What issues are we facing?

- Current operations often require rigs and large crews for ESP installation and replacement
- Expensive operations due to high rig costs
- Constraints in rig availability can lead to further delays
- Lost and deferred production
- Release rigs from working over failed ESPs
- Reduced productivity due to kill fluid

We need a step-change in capability and value, that addresses these issues

A New ESP Architecture – Overview for 4.5-in tubing

Size:	3.5” OD typical, <60ft long
Max. Ambient Temp:	135’C / 275’F
Pump:	High Speed Centrifugal
Motor :	PMM: 10,000 RPM 250/500hp (186/372kW)
Flow / Head:	8,000bfpd / 6,000ft
Integrated Monitoring:	Yes
Applications:	Conventional oil, Shales, Retrofit and Contingency Applications
Deployment:	1-in Cable (TEC) with small CT unit
Live Well Capable:	Yes
Sour Service:	NACE Compliant
Benefits:	Rigless deployment benefits. Brownfield redevelopment. Rapid response contingency ESP.

Design completed

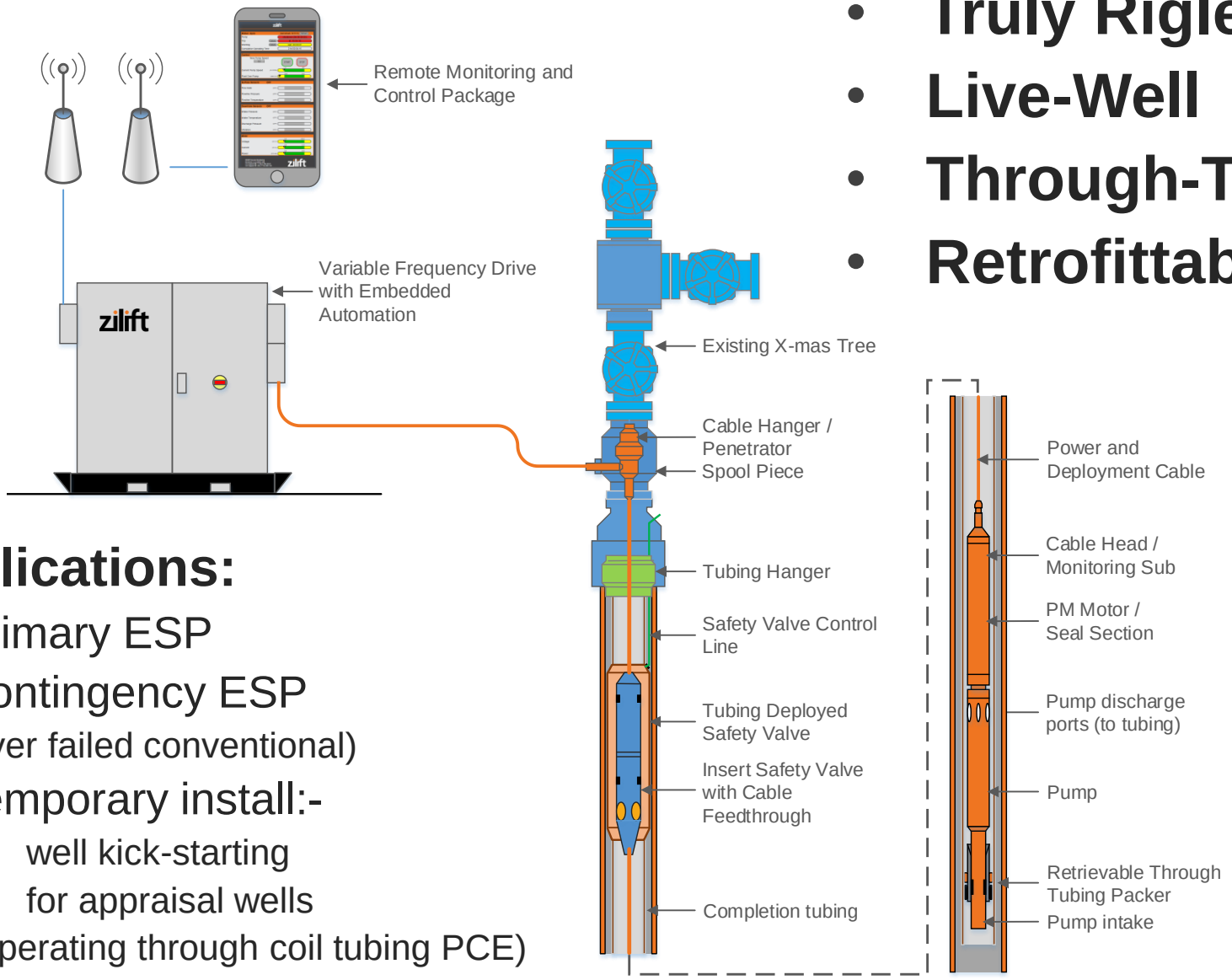
Manufacturing completed

Functional testing completed

FAT integrated testing completed

SIT deployment in test well completed

A New ESP Architecture - Overview



- **Truly Rigless**
- **Live-Well**
- **Through-Tubing**
- **Retrofittable**

Applications:

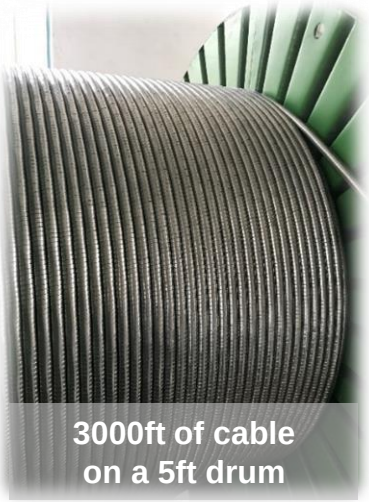
Primary ESP

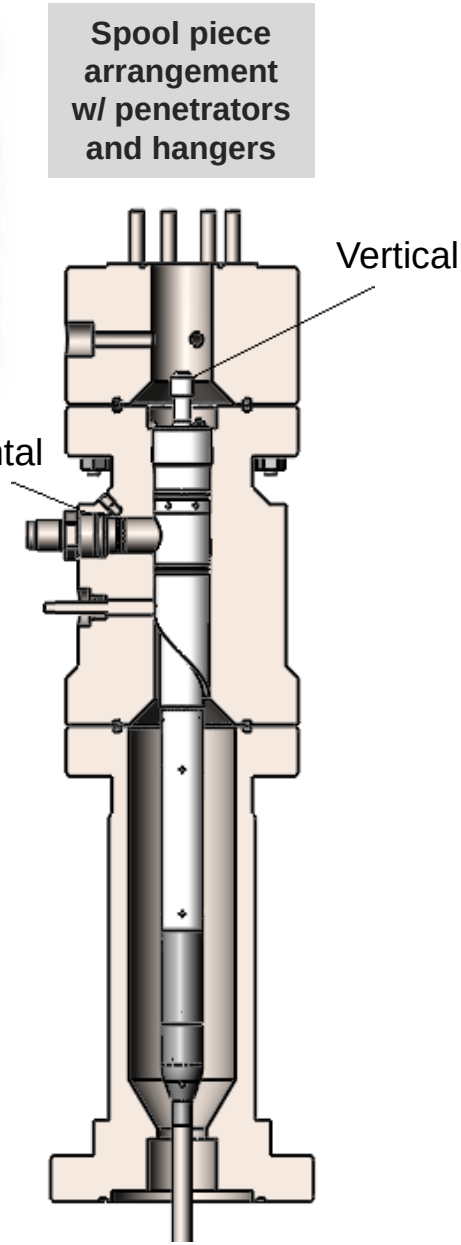
Contingency ESP
(over failed conventional)

Temporary install:-
well kick-starting
for appraisal wells
(operating through coil tubing PCE)

A New ESP Architecture – On Surface

- VFD
  - High speed motor control
  - Integration with PLC and SCADA
  - Skid mounted
- Wellhead Penetrator
  - Horizontal and vertical electrical penetrators
  - Spool piece mounted in tree prior to job
  - Test porting to verify integrity during live-well deployments
- Cable (reusable)
  - 1-in TEC, SS 2205 / Nickel 825
  - Single cable for conveyance, power and telemetry from downhole sensors

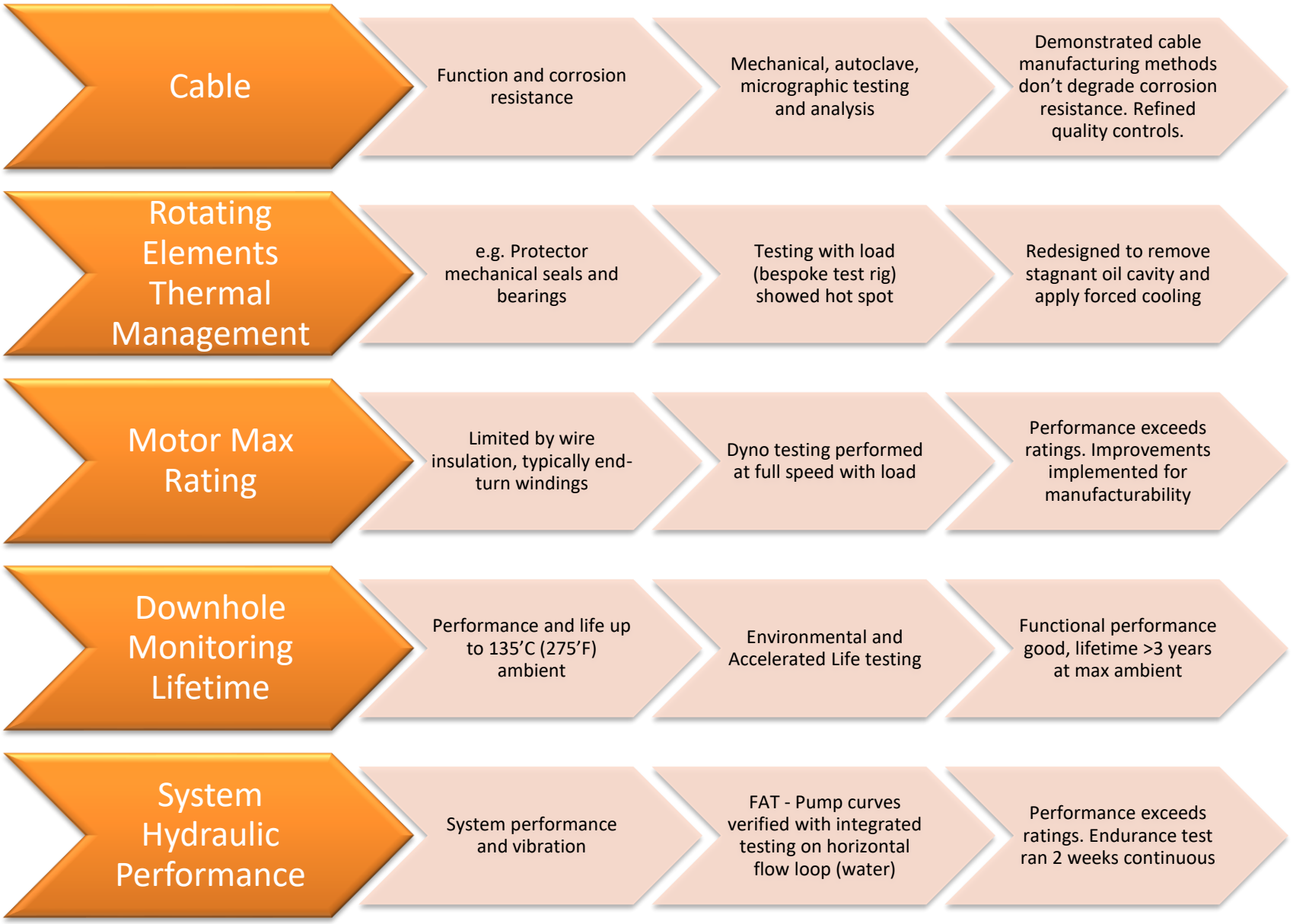




Design Considerations & Development Testing

- BHA Considerations
  - Through tubing fundamentally constrains OD – motor on top chosen
  - Power density critical, <60ft long desirable for ease of deployment Permanent Magnet Motor technology selected
  - High speed operation – must control vibration and heat
- Cable Considerations
  - Desirable to be truly rigless, allowing for rapid retrofit replacement
  - TEC construction allowing for live well deployment
  - Wire gauge tradeoffs – losses vs weight = efficiency vs max depth
- Other Considerations
  - Forced cooling utilised to manage temperature of high speed rotating contact elements – both working and clean fluid
  - Vibration – shaft design critical, with interim bearings required
  - Thrust – reacted independently in each module (motor, pump etc)

Design Considerations & Development Testing



Full Scale SIT in Test Well – Equipment Prep.

- Delivery to wellsite is on a std. flatbed for land wells
- Focus on ease of operations
- Safety further improved with lightweight tooling

(Above) – Downhole system is pre-built in workshop and only makeup is the two halves: Protector to Pump

(Below) – Lightweight tooling to ease manual handling

Full Scale SIT in Test Well – Single Piece Lift

- 2nd crane allows BHA makeup to be performed horizontally
- Test well but full live-well procedures were used throughout SIT
- Basic scaffold able to be used

Full Scale SIT in Test Well – Completion

- Hanger at surface used with running tools for final landout into spool
- Hookup to VFD completed and commissioning commenced
- System operated successfully at operating point for test well

Vertical penetrator held at surface prior to connecting running tools for landout

Horizontal penetrator connected to spool piece with pig-tail leading to VFD

Conclusions

- The industry must continue to adapt to reduce the cost of production in the face of ongoing uncertainty
- A forward looking cable-deployed ESP has been developed and tested, demonstrating widely applicable capability including sour service and up to 8000bfpd
- A truly rigless live-well through-tubing deployment method has been verified with a full scale SIT in a test well
- The system delivers a solution improves safety and economics by reducing crew and suspended load operations, as well as time and cost to establish / restore production
- Field deployment of the technology is upcoming

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Q & A

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