MIDDLE EAST ARTIFICIAL LIFT FORUM

Experiences Gained With the Application of Dual ESP System with Y Tool in Qatar

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Abstract

Deploying two ESP's in a well at the same time allows for the existence of a redundant ESP system which in turn leads to extended run life of the system. This results in reduced workover costs in the long term and minimizing "lost revenue" from deferred oil production whilst enabling scheduling for a workover program.

There are many challenges related to the deployment of a dual electrical submersible pumping system. This paper aims to share some of the experiences and challenges that were overcome during the technical design, preparation and execution of the first dual ESP applications in the Al-Khalij field in Qatar for Total E&P.

The main challenges that were overcome are presented in the paper including placement of a dual ESP in a highly deviated well, re-assessment of traditional maximum dog leg severity criteria, packer design, job preparation and execution techniques and post job monitoring and control.

The results of the paper will show that the methodologies and experiences gained allowed for the successful deployment of the first Dual ESP in Qatar.

Introduction

Dual ESP technology has many advantages over a single ESP system. They provide redundant ESP's for any type of operation, for example:

- Locations where the production downtime is a critical factor
- Rig availability to perform workover is restricted due to limiting factors such as extensive drilling programs or other project commitments.
- Any environment that is plagued with high workover costs.
- Remote locations that are difficult to access with workover rigs
- Sub-sea completions where time between work-overs can be extensive.

All of these types of operations lend themselves to dual ESP's in order to reduce the risk of production downtime. It also will reduce the number of work-overs over the life of the field, which reduces the amount of money spent on ESP change-outs.

Dual ESP's are being run at Total Al-Khalij field to provide redundancy within most of the wells. The original concept for having a dual ESP in Al-

Khalij field is to minimize "lost "revenue from deferred oil production whilst enabling scheduling for a workover program and also extended run life of ESP system. If an ESP failed in single completion, the well would cease production until the rig found an appropriate time when a workover could be performed. This might take several weeks and would lead to a considerable decrease in oil production. With two ESP's installed in each well, the second one can be switched on as soon as the first one fails. The production downtime for the well is minimized.

In addition, utilizing dual ESP's allows the flexibility of two different sized ESP's to be installed which results in an ability to produce a wider range of bottom hole flowing pressures and rates. This is especially useful on newly drilled wells where there may be some uncertainty as to the maximum achievable flow rate.

Different techniques have been used to deploy two ESP's in the same completion, depending on the wellbore configuration and conditions. Project objectives have varied from operator to operator and field to field, and each completion has been configured differently to provide each operator with the optimum solution. An important feature of each of the deployment configurations is standard ESP equipment is used in every completion.

Total are currently using the by-pass system using a single Auto Y-tool for deploying a dual ESP. This involves hanging the lower ESP from the by-pass leg of the upper system. When the lower ESP is operating, the by-pass system of the upper system becomes the production path past the upper ESP. The Auto Y-tool has a diverter (flapper), which can either seal over the ESP leg or the by-pass leg. It enables switching between either ESP systems without the need for intervention and prevents circulation of fluids through the redundant /non-working ESP. (see Figure 1 for diagram)

If access to the reservoir is required (i.e. production PLT) a second by-pass system (with Y tool) would need to be run with the lower ESP.

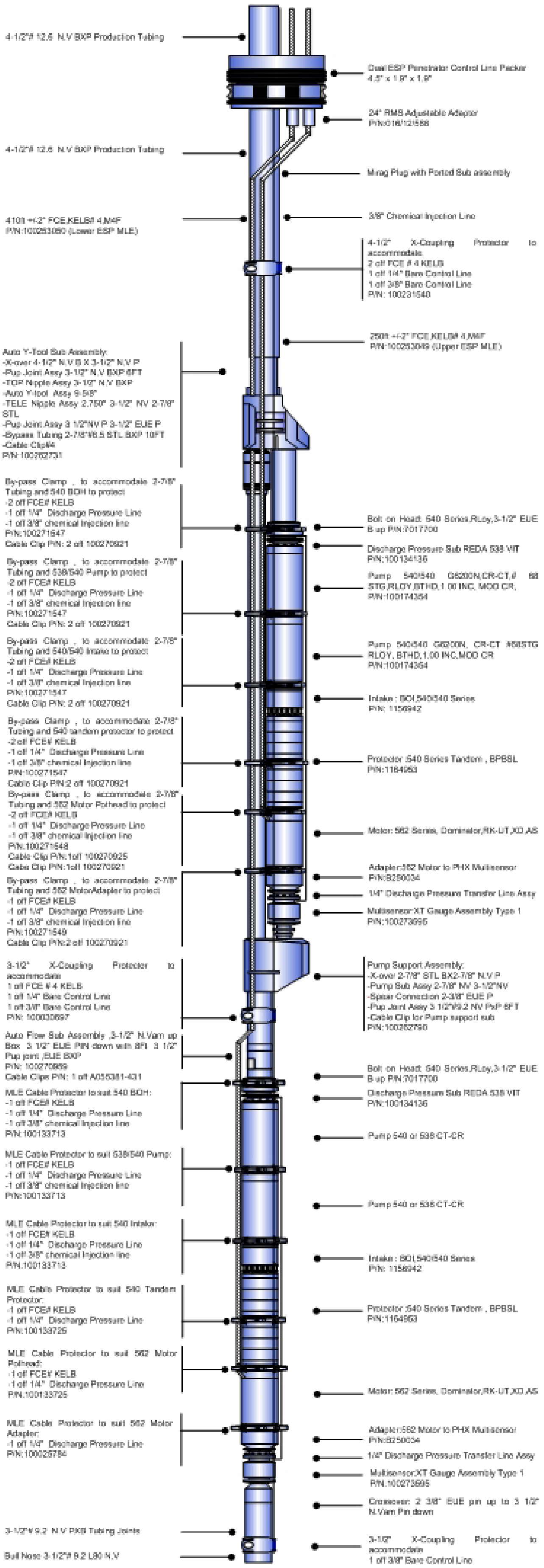


Figure 1: Total Dual ESP Completion Diagram

Lessons Learned

The lessons learned fall into two main categories:

1. Engineered solutions
2. Job Preparation and Execution

I. Engineered Solutions

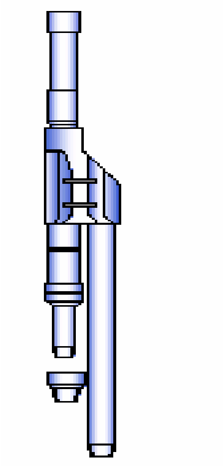
a) Collaborative Team Work

Much of the project success is due to the close collaboration between the local ESP team (Total and SLB), Schlumberger Centre of Excellence in the UK and the Total Technical Headquarters in France. The full team were engaged in laying out the project technical requirements to ensure a fit for purpose design was established for the Al Khalij field. The centre of excellence took a central role in managing the project to ensure open lines of communication between the various manufacturing centre's and contractors that were being employed.

One of the main project goals was to use as much proven commercialized technology as possible. Through the use of standard ESP technology provided by Schlumberger Reda, by pass system provided by Schlumberger Phoenix, packer equipment by Petrowell and packer penetrator system through RMS this goal was realized. For all equipment sourced through Schlumberger specific part numbers and associated drawings were created for Total Al-Khalij inclusive of the special Total Quality Control requirements. This ensured a smooth transition of information through the various manufacturing plants and processes.

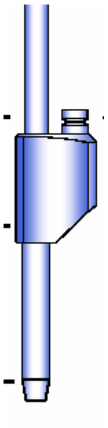
b) Sub Assemblies

One of the main solutions provided was the pre-packaging of the equipment into sub assemblies directly from the manufacturing plant. Several sub assemblies were torqued and pressure tested in the manufacturing plant before shipment to Qatar. This allowed for enhanced quality control and faster installation at the rig site. The sub assemblies provided by Phoenix were as follows:



Y Tool Sub Assembly

- X-over 4 1/2" NV to 3 1/2" NV
- Handling sub 3 1/2" NV 6ft
- PHX top nipple 3 1/2" NV BxP
- Auto Blanking Y-Tool
- Pump sub 3 1/2" NV PxP 10ft
- X-over 3.5" N.V to 3.5" EUE
- Telescopic Swivel, 3 1/2" N.V Pin Up x 2 7/8" ST-L
- By-Pass Tubing Joint 2 7/8" STL B x P 10ft



Pump Support Sub Assembly

- X-Over 2 7/8" ST-L B x 2 7/8" NV. P
- Pump Support Sub 3 1/2"
- Pup Joint Assy 3 1/2" NV P x P 6 ft
- Spear

c) Stress and Deflection Analysis

Since the Dual ESP require longer tangent, for each type and each individual well, stress and deflection needs to be calculated in order to find the possibility to run the dual ESP safely for that particular well.

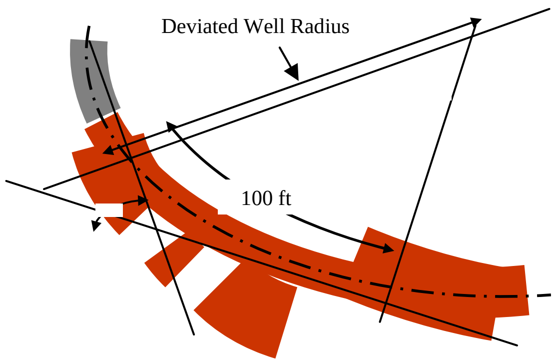
Many of the Al Khalij wells have high dog leg severity sections which when analysed with the standard industry wide stress and deflection analysis criteria result in the advice being not to install the pump at this depth. In fact in many of the Al Khalij wells it would not be advisable to install an ESP at any depth. However Total has experience of installing pumps in high dog leg severities above the recommended benchmark criteria for many years with no problems. This led to a re-assessment of the stress and deflection criteria for the Al-Khalij field to produce new benchmark criteria.

The new benchmark for stress and deflection for wells in Al-Khalij were created based on the history of the wells in this field, current setting depth and life time of ESP's.

It must be noted that for any well that has a dog leg severity of <1deg/100ft at the pump setting depth a deflection analysis is not required. If the pump will pass through a section in the casing which could lead to a DLS on the ESP>6deg/100ft, a deflection analysis is required using the standard running in hole benchmark criteria (these have not been discussed in this paper as they were not modified for the Al-Khalij field)

For the Al Khalij field each well was considered with an ESP design performed for each well to identify the type of equipment required for each well. From this analysis it was observed that the longest ESP configuration required is around 30m long. So for dual ESP configuration, approximately 2 x30m section (setting the upper and lower ESP) and 20m distance between two ESP was considered. The 20m distance between the ESP's is to: allow for the tubing to deflect and compensate for eccentricity between the two systems; and to minimize the bending effect of the lower system on the upper system.

In deflection analysis the ESP string is considered as a beam under deflection with different cross sections in its full length. The moments and products of inertia are calculated for the different sections. In the beams conventional calculations the loads applied to the beam induce deflection and stresses. In the case of an ESP in a deviated well the stresses are calculated departing from a known deflection condition of the ESP string. The software considers the ESP string as a beam bended with the shape of a circular arc and calculates the deflection and stresses for each section of equipment considering the effect of the sections connected at its head and base. As the ESP string tends to accommodate in the space available in the casing the deformation/deflection will depend on the angle, which is constant for the complete ESP string, the casing ID and the geometry of the ESP string (OD, ID and length of every section of equipment: tubing, pump, intake, protector, motor, etc.). Stiffer sections will tend to induce higher stress and deflection to weaker sections however; this depends on the length of the particular components connected at the base and head.



Every particular configuration has its own way to yield/resist to the induced stresses and deflections. In other words, a specific ESP configuration must be available to assess the stresses and deflections of an ESP string in a given dog leg severity (DLS). For these reasons a maximum DLS cannot be supplied as a general recommendation.

The process to conduct a Deviation Analysis is the following:
Study the well deviation survey to determine the maximum dogleg while running the ESP string and the try to find a "straight enough" section of well to set the equipment. Use ESP deflection analysis software to generate Moment, Deflection, Stress, and Bending on the ESP string and Summary diagrams. The result of the Deviation Analysis with the respective Stress and Deflection Benchmarks for every section of equipment is compared. A separate analysis is required for the

Deviation Analysis while running the ESP string in the well and a second one for the setting of the ESP. To determine the maximum dogleg for setting/running an ESP string in a deviated well is a time–consuming trial and error process. Since the results of the Deviation Analysis rarely match the benchmarks several iterations (4-5 generally) have to be performed to determine the maximum dogleg allowed for the ESP string to be run/set in the well.

A new benchmark table for Alkhalij wells was created using this methodology. Table 1 shows the summary of the of the new benchmarks created for TOTAL Alkhalij field based on results from the stress & deflection analysis for current wells equipped with single ESP.

Length (FT)	Standard & Alkhalij Running Benchmarks (inches)	Standard Setting Benchmarks-(inches)	TOTAL Alkhalij Field Setting Benchmarks-(inches)
5	0.069	0.007	0.010
6	0.099	0.010	0.015
7	0.135	0.014	0.020
8	0.176	0.019	0.026
9	0.222	0.024	0.033
10	0.275	0.029	0.041
11	0.332	0.035	0.049
12	0.395	0.042	0.059
13	0.464	0.049	0.069
14	0.538	0.057	0.080
15	0.618	0.066	0.092
16	0.703	0.075	0.104
17	0.794	0.084	0.118
18	0.890	0.094	0.132
19	0.991	0.105	0.147
20	1.098	0.117	0.163
21	1.211	0.129	0.179
22	1.329	0.141	0.197
23	1.453	0.154	0.215
24	1.582	0.168	0.234
25	1.716	0.182	0.254
26	1.856	0.197	0.275
27	2.002	0.213	0.297
28	2.153	0.229	0.319
29	2.309	0.245	0.342
30	2.471	0.262	0.366
31	2.639	0.280	0.391
32	2.812	0.299	0.417
33	2.990	0.318	0.443
34	3.174	0.337	0.470
35	3.364	0.357	0.498

Table 1: New Benchmark for setting ESPs in Alkhalij Field

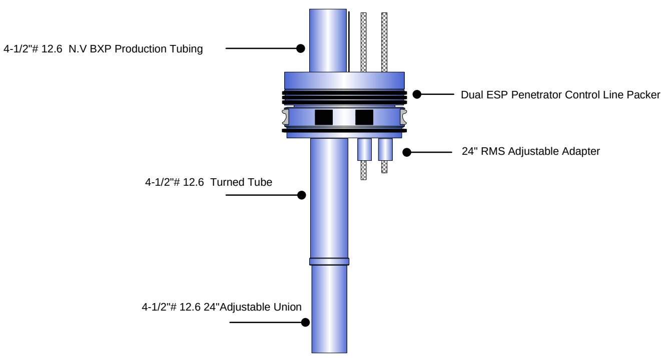
d) Packer Penetrator and Packer Design Considerations

For the dual ESP application a dual ESP packer is required. During the design phase of the project it became apparent that in order to allow for two cable feed through's in the packer the bore diameter requirement would need to be less than the packer penetrator diameter. For all Al Khalij single ESP installations a top feed penetrator is used which requires the penetrator to pass through the cable bore in the packer as the penetrator is tightened from the top of the packer. This would not be possible for the dual application and hence a bottom fed penetrator would be required. The bottom fed penetrator allows for the penetrator to be tightened from below the packer and hence the penetrator does not have to pass through the packer bore. This was sourced through Remote Marine Systems (RMS).

One further challenge was that using a standard 4.5" pup joint below the packer would not be possible as the OD of the pup joint with a packer penetrator fitted alongside would not fit into the 9 5/8" casing. A machined down 4.5" turned spacer tube was supplied by the packer manufacturer (Petrowell)

During the design phase of the project it was deemed necessary to have a minimum of a 20m space out between the lower and upper ESP systems. This coupled with the lengths of the equipment led to a design specification of 160ft difference between the upper and lower motor lead extensions (MLE) to be used. As a result, the lower ESP is installed with a 410ft MLE and the upper with a 250ft MLE.

Due to the fixed length MLE with penetrator attached to the end, space out of the ESP becomes critical. It is not feasible to achieve the exact space out requirements using pup and tubing joints. The main reason for this is that the minimum length pup joint available is 1ft, so if space out of less than 1ft is required it would not be possible to achieve this with pup joints alone. Also the manufacturing variation in joints can sometimes be significant which would cause space out to be a trial and error process.



24 "Adjustable Adaptors and Adjustable Union

To overcome this, two adjustable completion equipment types were incorporated. First an adjustable union with a 24" adjustment was used below the turned spacer tube. This adjustable union allows for space out of both the upper and lower ESP, up to the packer, to accommodate the space out not achievable with pup joints.

The lower and upper ESP's also need to be spaced out exactly. The majority of this space out is done with the 3.5" pup joints between the upper and lower ESP. Again it is not feasible to achieve the exact space out requirement using pup joints alone. The 24" adjustable adaptors were used to make the individual adjustments to each cable required to achieve the space out between the upper and lower ESP.

II. Job Preparation and Execution

a) System Integrity Test (SIT)

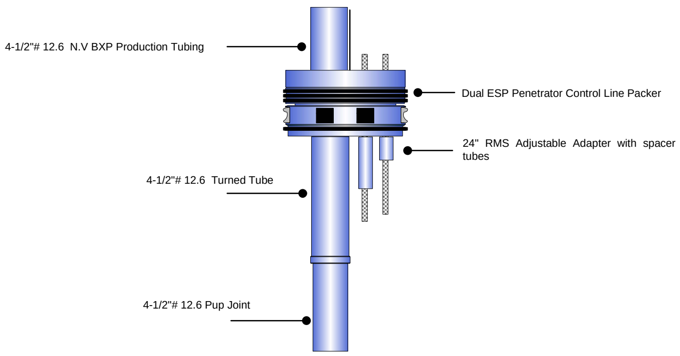
An SIT was performed in the UK at the Centre of Excellence using a 200ft test well. Representative equipment to the Total equipment was installed. The Qatar ESP team (both SLB and Total) took part in the test as well as the Centre of Excellence. This allowed the Total and SLB engineers a full picture at what the installation procedure would be for the upcoming well. The observations made during the test were incorporated into the installation procedure.

b) Local Sub Assemblies

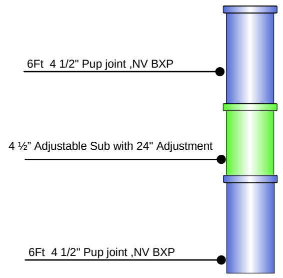
Prior the equipment being shipped to the rig substantial preparation work was performed in order to negate any potential service quality issues.

Not all of the equipment was supplied by one manufacturer and hence some of the sub assembly work was carried out locally prior to the job. The following sub assemblies were torqued and pressure tested locally in Qatar:

- Packer Sub Assembly



- Adjustable Union Sub Assembly



c) Space Out Requirement Identified

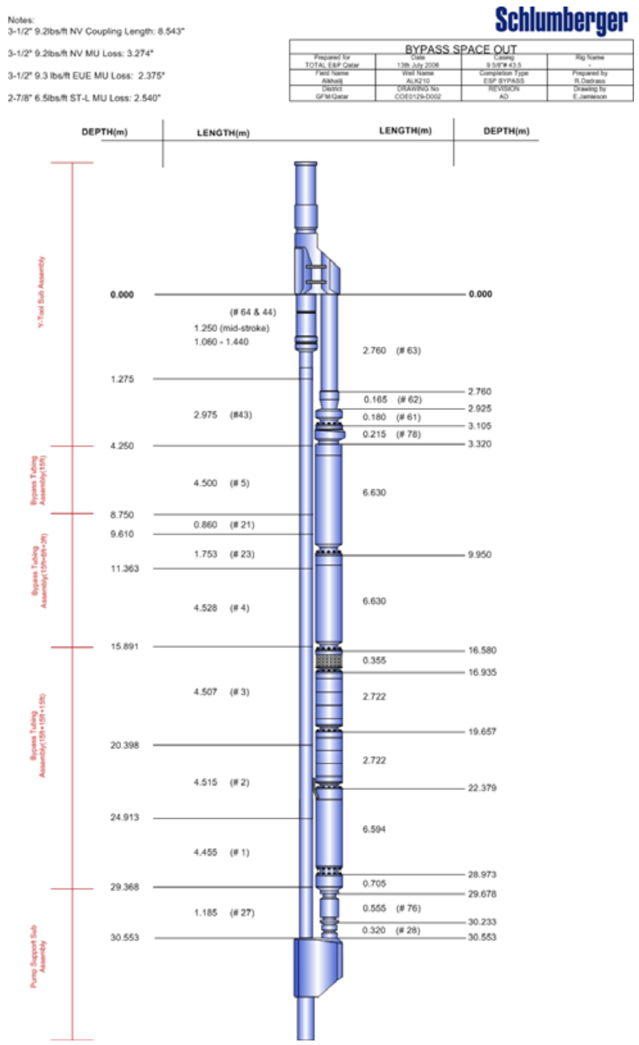
Each piece of equipment was measured in the workshop and the following space out drawings were created

- Space out between upper and lower esp. This allowed for pup joint requirements between the ESP's to be identified and exact pup joints to be selected and marked prior to shipment to the rig. (see completion drawing in Appendix A)

- Space out requirement from the ESP's to the packer. This allowed for pup joint requirements from the y tool to the packer to be selected and marked prior to shipment to the rig. Also the expected adjustment to the adjustable union was calculated to ensure that the calculation was within the limits of the union (see completion drawing in Appendix A)

Expected packer penetrator adjustment was calculated to ensure within range of penetrator adjustment range

- By pass tubing space out performed which allowed for selection of by pass tubing pup joints. This was especially important as a 3ft gap between the pup joint and the ESP equipment is required in order to allow for space for the tongs to clamp to. The by pass tubing joints were selected and marked in the order they would need to be installed (figure on next page shows by pass tubing space out diagram used)



Results

Total E&P installed the first dual ESP in the Al-Khalij field successfully in August 2006. The unit is running today successfully with no recorded downtime. The installation was performed with no service quality incidents or lost time.

The Dual ESP system is composed of:

- Lower ESP: SN8500 ESP (2x43 stages) with a 270 HP motor.
- Upper ESP: G62000N ESP (2 x 68 stages) with a 270 HP motor.

By Pass Tubing Space Out Diagram

It is estimated the rig time saved as a result of the sub assemblies pre-made are:

Sub Assembly	No. of Connections	Rig Time Saved (hrs)
Y Tool	7	4.7hrs
Pump Support Sub	4	2.7hrs
Packer	7	6.0hrs
Adjustable Union	2	1.3hrs
Total	**14.7hrs**	

Future Improvements

As a result of the first dual ESP install some further improvements were identified to enhance the efficiency of the installation. These improvements include:

1). Use of slips with larger gap for to accommodate the dual cables. The original slips used allowed for a minimal gap for the cable to reside in which if extreme care is not taken during install could cause the cable to become damaged accidentally.

2). Placement of the MLE cables on the rig floor could be enhanced through the use of a specially designed basket for carrying the cables in. The basket will have proper latching hooks to allow for simple crane pick up.

3). Presently “Well A” ESP is driven by a Leroy Somer 270T Variable Speed Drive and using a standard 600 kVA transformer. Currently this requires each ESP changeover to be performed via a process of swapping between the cables in the transformer. This is a manual process that requires the electrician each time to disconnect one set of ESP cable and reconnect the other set.

The future growth of Dual ESP installations across the Alkhalij field is expected to be substantial. This has prompted Total to request the design of a new transformer for Dual ESP that does not require manual changeover of the cable. This new transformer type will be equipped with a high voltage offload selector facilitating the ESP change over in terms of risk and duration.

Conclusion

“Well A” began operation on the 13th of August 2006 using the lower string as the main ESP.

The well parameters at the start up were:

- Gross flowrate = 7500 bpd
- BSW = 29%
- WHP = 30 barg
- ESP frequency = 51 Hz

After 5 months of production, the lower ESP is still operating as per the theoretical pump curve.

Total philosophy is to operate the lower ESP) as the main ESP and to keep the upper one as a back up.

The main ESP is operated continuously and a procedure was put in place to ensure that the back up ESP is to be tested once every 4 months for a period of one week. This procedure was tested on October 6th 2006 whereby a 24hour test was successfully performed using the backup ESP.

Today TEPQ has a preventive workover policy that ensures that ESP wells are scheduled for work-over when degradation in production is witnessed. This means that the ESP's are usually pulled out before they actually fail. As a consequence current average run lives are 34 months.

The Dual ESP's will allow performing the work-over of the well only after the main ESP string fails. But it will allow also regrouping several work over by performing a work over campaign on a dedicated platform. In fact, to optimize the work over planning, the back up ESP will be run until the best window for the well work over will be reached (several work over to be performed on the same platform for instance).

With the progressive abandonment of the present preventive work over policy, it is expected that the average run life of the ESP's will be increased to 48months. The Dual ESP installations will consequently have a significant impact on the well working factor as well on the number of work over to be performed each year on the field.

Total plan to install a further 5 Dual ESP installations in the Al-Khalij field throughout 2007. Currently a Dual Pod completion project is being investigated, as a 9 5/8'' Casing corrosion mitigation mean.

Appendix A - Completion Schematic

TOTAL E & P Qatar	PROPOSED COMPLETION	Well A

N°	Bottom hole equipment	ID	OD	Depth	Length
	Distance Rotary Table to top hanger			21.79	21.79
1	13"5/8 x 10"3/4 Tbg hanger 4.909 top w/ 4" BPV profile	4.000	9.875	22.91	0.61
2	4-½" pup joint , Nvam 12.6#, C95, 13CR, 5Ft long	3.958	4.500	24.69	1.78
3	2 Ft 4-½" pup joint , Nvam 12.6#, C95, 13CR	3.958	4.500	25.30	0.61
4	15 Ft 4-½" pup joint , Nvam 12.6#, C95, 13CR	3.958	4.500	29.87	4.57
5	15 Nos 4-½" tubings, Nvam 12.6#, C95, 13CR	3.958	4.500	172.07	142.20
6	4-½" pup joint , Nvam 12.6#, C95, 13CR, 5Ft long	3.958	4.500	173.64	1.57
7	4-½" Flow coupling Halliburton	3.958	4.950	175.37	1.73
8	Halliburton wellstar 3.81 TRSCSSV 4"1/2 Nvam	3.813	6.620	176.94	1.57
9	4-½" Flow coupling Halliburton	3.958	4.950	178.67	1.73
10	4-½" pup joint , Nvam 12.6#, C95, 13CR, 3Ft long	3.958	4.500	179.64	0.97
11	153 Ft 4-½" pup joint , Nvam 12.6#, C95, 13CR	3.958	4.500	1630.08	1450.44
12	4-½" pup joint , Nvam 12.6#, C95, 13CR, 5Ft long	3.958	4.500	1631.66	1.58
13	9"5/8 OPBO Packer 43.5-47# PPF 4"1/2 Nvam 12.6# L80	3.916	8.348	1633.17	1.51
14	4-½" turned tube L80, 12.6# Nvam	3.958	4.500	1639.89	6.72
15	4-½" pup joint , Nvam 12.6#, C95, 13CR, 3Ft long	3.958	4.500	1640.87	0.98
16	4-½" pup joint , Nvam 12.6#, C95, 13CR, 5Ft long	3.958	4.500	1642.63	1.76
17	Adjustable sub (0.61 m stroke) Open = 0.07	3.856	5.905	1644.34	1.71
18	4-½" pup joint , Nvam 12.6#, C95, 13CR, 3Ft long	3.958	4.500	1645.23	0.89
19	5 Ft 4-½" pup joint , Nvam 12.6#, C95, 13CR	3.958	4.500	1646.75	1.52
20	20 Ft 4-½" pup joint , Nvam 12.6#, C95, 13CR	3.958	4.500	1652.85	6.10
21	4-½" pup joint, Nvam 12.6#, C95, 13CR, 5Ft long	3.958	4.500	1651.71	1.76
22	Ported sub, Nvam 12.6#, ASI 420	3.958	4.500	1651.96	0.25
23	4-½" pup joint , Nvam 12.6#, C95, 13CR, 3Ft long	3.958	4.500	1652.85	0.89
24	4-½" pup joint, Nvam 12.6#, C95, 13CR, 5Ft long	3.958	4.500	1654.61	1.76
25	Mirage plug, Nvam 12.6#, C95, 9CR	3875	7.730	1655.61	1.00
26	4-½" pup joint , Nvam 12.6#, C95, 13CR, 3Ft long	3.958	4.500	1656.50	0.89
27	3 Nos 4-½" tubings, Nvam 12.6#, C95, 13CR	3.958	4.500	1684.94	28.44
28	X-over 4-½" Nvam x 3-½" Nvam	2.992	4.900	1685.21	0.27
29	3-½" pup joint Nvam L80 9.2#, 13CR, 6 Ft long	2.992	3.900	1686.96	1.75
30	Top nipple assemnly 3-½" Nvam Box	2.812	3.900	1688.10	1.14
31	Auto Y tool assembly 9-5/8", AISI 420	2.992	8.250	1688.83	0.74
32	X-over 3-½" Nvam x 3-½" EUE, AISI 420, 10 Ft	2.992	3.75	1691.76	2.93
33	Bolt on head flange x3-½" EUE, Rloy for Y tool	2.750	5.250	1691.94	0.18
34	Discharge Pressure Sub flanged, AISI 420	2.865	5.380	1692.15	0.21
35	Pump GN6200 CR-CT 68 stages. Rloy, HSS, 1.00 INC	4.527	5.125	1698.78	6.63
36	Pump GN6200 CR-CT 68 stages. Rloy, HSS, 1.00 INC	4.527	5.125	1705.41	6.63
37	Intake ARZ: BOI, 540/540 RLOY, INC	2.560	5.380	1705.76	0.36
38	Protector 540 series BPBSL NTB/KTB, 1.18 Rloy	4.534	5.380	1708.48	2.72
39	Protector 540 series BPBSL NTB/KTB, 1.18 Rloy	4.534	5.380	1711.20	2.72
40	Motor 270HP@60Hz, 2545V, 64.5A, F094, Rloy, HSS, INC	5.220	5.630	1717.79	6.59
41	Motor adaptor Phoenix multisensor MTR 562, Rloy	5.220	5.630	1718.49	0.70
42	Multi- sensor typeMDT-XT	3.530	4.500	1719.05	0.56
43	2.⅜" Spear, plug & collar, 2.⅜" EUE pin			1719.37	0.32
44	Pump support sub, 2.⅞" EUE x 3-½" Nvam	2.441	8.250	1719.88	0.51
45	3-½" pup joint L80 9.2# Nvam, AISI 420, 6 Ft long	2.992	3.900	1721.56	1.68
46	2 Nos 3-½" tubings Nvam 9.2# L80 13CR	3.958	4.500	1740.52	18.96
47	4 Ft 3-½" pup joint Nvam 9.2# L80 13CR	2.992	3.900	1741.80	1.28
48	3 Ft 3-½" pup joint Nvam 9.2# L80 13CR	2.992	3.900	1742.77	0.97
49	15 Ft 3-½" pup joint Nvam 9.2# L80 13CR	2.992	3.900	1747.27	4.50
50	3-½" pup joint, Nvam Pin x Box, 9.2# ,13CR, 5 FT long	3.958	4.500	1747.27	1.45
51	Auto flow sub 3-½" Nvam x 3-½" EUE	2.992	5.595	1747.99	0.71
52	Bolt on head flange x3-½" EUE, RLOY	2.750	5.250	1748.17	0.18
53	Bolt on head sensor 538/540 series discharge pressure	2.62	5.99	1748.24	0.07
54	Pump SN8500 CR-CT 43 stages. Rloy, HSS, 1.00 INC	4.820	5.380	1752.29	4.06
55	Pump SN8500 CR-CT 43 stages. Rloy, HSS, 1.00 INC	4.820	5.380	1756.35	4.06
56	Intake ARZ: BOI, 540/540 RLOY, INC	2.560	5.380	1756.71	0.36
57	Protector 540 series BPBSL NTB/KTB, 1.18 Rloy	4.534	5.380	1759.43	2.72
58	Protector 540 series BPBSL NTB/KTB, 1.18 Rloy	4.534	5.380	1762.15	2.72
59	Motor 270HP@60Hz, 2545V, 64.5A, F094, Rloy, HSS, INC	5.220	5.630	1768.74	6.59
60	Motor adaptor Phoenix multisensor MTR 562,Rloy	5.220	5.630	1769.44	0.70
61	Multi- sensor typeMDT-XT	3.530	4.500	1770.00	0.56
62	Xover 2-⅞" EUE x 3-½" Nvam		3.500	1770.21	0.21
63	1 Nos 3-½" Tubings L80 9.2# Nvam (empty)	2.992	3.500	1779.69	9.48
64	Bull nose 3-½" L80 9.2# Nvam		3.500	1780.04	0.35

	Miscellaneous (Casing, Plug, Fish...)	ID	Lbs/ft	Bot depth	Top depth
1	9"5/8 casing 43.5# L80 BTC	8.755	43.5	2096.00	
2	6.5/8" liner 24# L80 Hydril 521	6.276	24	4540.00	2042.00
	2-⅞" by pass tubing made with:				
	Auto Y tool assembly 3-½" Nvam, AISI 420			1688.85	0.74
1	Tele swivel nipple (0.38 cm stroke) Open = 0.2	2.992	8.250	1690.10	1.25
2	10 Ft 2-⅞" pup joint L80 6.5# ST-L 13Cr			1693.08	2.98
3	15 Ft 2-⅞" pup joint L80 6.5# ST-L 13Cr			1697.58	4.50
4	3 Ft 2-⅞" pup joint L80 6.5# ST-L 13Cr			1698.44	0.86
5	4 Ft 2-⅞" pup joint L80 6.5# ST-L 13Cr			1700.19	1.75
6	15 Ft 2-⅞" pup joint L80 6.5# ST-L 13Cr			1704.72	4.53
7	15 Ft 2-⅞" pup joint L80 6.5# ST-L 13Cr			1709.22	4.51
8	15 Ft 2-⅞" pup joint L80 6.5# ST-L 13Cr			1713.74	4.52
9	15 Ft 2-⅞" pup joint L80 6.5# ST-L 13Cr			1718.19	4.46
10	4 Ft 2-⅞" pup joint L80 6.5# ST-L 13Cr			1719.37	1.18
11	Pump support sub, 2.⅞" EUE x 3-½" Nvam		8.250	1719.88	0.51

Perforation intervals				Comments	30.52
	Depth	Type	Status		
				Pressure test annulus packer at 69 bar, Ok.	
				3/8" check valve w/ rupture disc sheared.	
				3.1/2" New Vam tail pipe run empty	

Max inclination	
Packer fluid Type	Brine
SG	1.00
Completion type	Simple
Weight	
Weight/Height on PKR	Neutral position
Rig	
Reference depth	Rotary table
Final depth	MSL / RKB = 36.50 m
Type of SCSSV	Tubing retrievable valve
Type of Packer	Retrievable Pump packer
Bottom gauge	
Tubing OD	4"1/2
Production casing OD	9"5/8 - 6-5/8"
Activation type	Electrical pump