PROCEEDINGS, 13th Indonesia International GEOTHERMAL Convention & Exhibition 2013
Assembly Hall - Jakarta Convention Center Indonesia, June 12 – 14, 2013

# LESSON LEARN OF WORKOVER MECHANICAL PROGRAM IN AN INJECTION WELL AT DIENG'S GEOTHERMAL FIELD

Mochamad R. Yoan[1], Anggi Wijaya[1], M. Thasril[2]

[1]Petroleum Engineering ITB, Jalan Ganeca 10 Bandung, moch.ramadhan@students.itb.ac.id; anggi.wijaya@students.itb.ac.id
[2]PT. Geo Dipa Energi Unit Dieng, m.thasril@gmail.com

## ABSTRACT

Deposits of silica scales cause a lot of problems during exploitation stage in some geothermal fields around the world. Silica scales deposition occurs in wellbore and along the pipe networks, that cause the reduction of productivity and injectivity of production and injection wells. Based on the history, silica scales often occur in injection wells. Silica deposition in the wellbore can be removed by chemical and or mechanical treatments. Reduction of injectivity of this injection well can be used as the first indication of silica scale deposition in the wellbore. To get some information about the condition of the well, a well investigation should be done before mechanical cleaning program is performed. This paper covers complete process of workover job with mechanical treatment including the work design, execution and post activities with some lesson learn and recommendation.

## INTRODUCTION

### Dieng Geothermal Field

The Dieng water-dominated geothermal field is located at Dieng Plateau, Central Java, about 90 km west from the capital city of Central Java, Semarang and about 80 km northwest of the city of Yogyakarta. The Dieng geothermal field is developed from elevation about 2000-2100 meters a.s.l with temperature range of 10-20°C. That cold temperature, with high intensity of rain at the mountain, and a lot of hydrothermal manifestations support Dieng geothermal field as one of tourism objects at Central Java. Most part of the plateau has been cultivated and the well sites are surrounded by scattered villages. The site can be reached by two different routes, which are via Banjarnegara and via Wonosobo.

The Dieng geothermal field is formed by a set of volcanic range composed by quartenary andesitic volcanic rocks (Layman, 2002). Manifestation of thermal activities in this field consists of solfatars, mudpools, hot springs, fumaroles, and moffets (Calibugan, et al., 2000). These thermal manifestations occur in both high and low elevation areas (Boedihardi, 1991). At higher elevation, the manifestation consists of fumaroles, acid sulphate boiling pools, and mud pools, while at lower area the thermal activities are characterized by hot and warm springs.

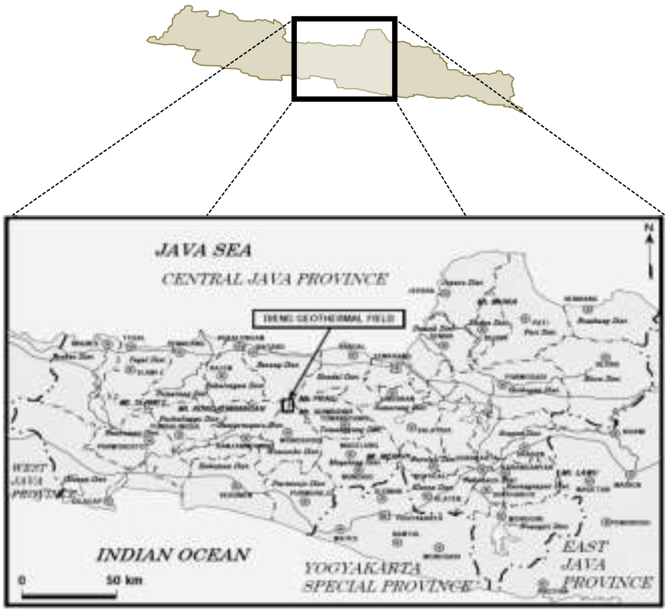


*Figure 1: Location of Dieng Geothermal Field*

The reservoir temperature of this geothermal field is greater than 225°C and can be classified as high temperature reservoir system. From the study by Layman (2002), significant variations of brine and gas chemistry are observed across Dieng resources. The field can be divided as two sectors, which are Sileri and Sikidang. Sileri reservoir fluids are moderate salinity, neutral pH, with low gas content. Sikidang sector associates with moderate depth feed zones, high enthalpy, and gas rich fluids.

Nowadays, a 60 MW power plant has been developed and produced electricity from around 7 production wells and 4 injection wells. The Dieng Geothermal Field is owned by PT. Geo Dipa Energy Unit Dieng (PERSERO). During the production, there were a lot of problem because of scaling at subsurface and surface facilities. In 2012, PT. Geo Dipa Energi was done some workover in production and injection well which the result was really good for production output.

In this paper, the author really interest on describing a lesson learn from one of injection well workover program which was had done in 2012. Lessons learn will be described in 3 different step: workover design, workover execution and post-activities.

## BEFORE WORKOVER

### Well Investigation

Well-10 is a vertical well that drilled on April, 25$^{th}$ 1994 and finished on July, 22$^{nd}$ 1994, located at Pad 10. The total depth of this injection well is 2300 meters and categorized as standard hole with slotted and perforated liner's inside diameter is 7". Total loss circulation was reached at 2122 meters. The configuration of casing that had been run in this well is:

- Casing 13 3/8" : 0-304 m
- Casing 9 5/8" : 0-1198 m
- TOL (Top of Liner) : 1139 m
- Liner 7" (Blind) : 1139-1783 m
- Liner 7" (Perforated) : 1783-2290 m
- Open hole : 2290-2300 m

Injectivity decrease can be used as the first indication that there could be an obstacle in subsurface that caused the brine couldn't be injected into the reservoir through this well. Because of that, some well investigation program should be conducted to confirm the cause of this problem.

The instruction work flowchart for the investigation program can be seen in Figure 2 (attached). The investigation programs that could be run in this well are:

1. Go Devil/Gauge Ring
2. Sample catcher
3. Impression Block

These investigation programs were the minimum investigation that can figure out the problems of well, whether it was scaling or casing problems. Caliper logging could not be considered because the output can't be achieved as expected. Beside that it was more expensive than another investigation program.

Configuration of the tools for this investigation program is shown in Figure 3. Go Devil/Gauge ring is a running tool that can detect maximum clearance area of the well. This tool will be tagged if there were an obstacle in the well which is bigger than the diameter of the tool. The information from this first investigation was really useful to conduct another step of investigation such us scale catcher and impression block.

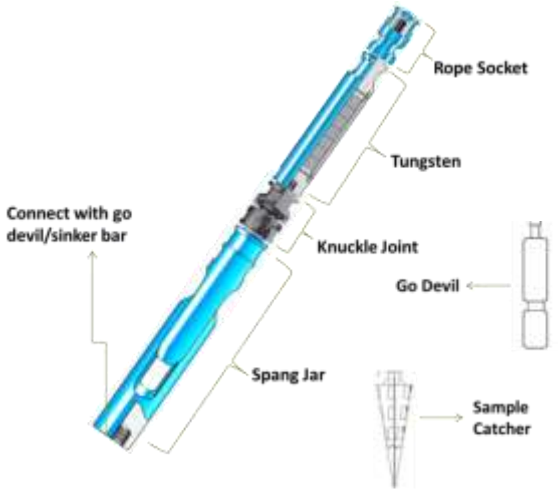


*Figure 3: Investigation toolstring*

The tool string assembly consisted of a spang jar, knuckle joint, tungsten, and rope socket. A spang jar was used to help the string grind the scale inside the wellbore. A knuckle joint made the string more flexible while the tungsten made the string heavier. Wireline is connected with a rope socket.

*Figure 4: Scale from the wellbore investigation.*

Firstly, a go devil with diameter was run and it tagged at 164 meters. Then, a sample catcher with diameter was run and tagged again at 162.8 meters from the surface. The sample catcher found some silica scale at that depth. It's mean that maximum clearance of this well was just until 162 meters. The depth below assumed full of scale because there was no tool that can be run inside the well. A well schematic that shows maximum clearance area before the workover program is attached at the end of this paper. The impression block was not run because the sample catcher had found the scale.

**Workover Planning**

The basis of workover planning is the results of well investigation analysis. Based on the well investigation using go devil and scale catcher tools, it yields the information about the clearance area of well that is previously described. It also gives the information about the scale existing in the wellbore. To remove the scale from this well, the appropriate workover program is redrilling the scale, start at that depth. Specification of the rig components are presented below.

| | |
|---|---|
| Maximum Rig Power | : 550 HP |
| Maximum Hook Load | : 180 klbs |
| Type of Drill Pipe | : $3\frac{1}{2}$” grade G-105 dan 5” grade G-105 |
| BHA Program | : |

*Table 1: Bottom Hole Assembly for 8.5” bit*

| BHA Component | Length (m) |
|---|---|
| Bit $8\frac{1}{2}$” | 0.37 |
| Bit Sub | 0.86 |
| Drill Collar $4\frac{3}{4}$” | 18.87 |
| Bumper Sub | 1.42 |
| Jar | 2.13 |
| Drill Collar $4\frac{3}{4}$” | 46.42 |

*Table 2: Bottom Hole Assembly for 6” bit*

| BHA Component | Length (m) |
|---|---|
| Bit 6” | 0.18 |
| Bit Sub | 0.86 |
| Drill Collar $4\frac{3}{4}$” | 18.87 |
| Bumper Sub | 1.42 |
| Jar | 2.13 |
| Drill Collar $4\frac{3}{4}$” | 46.42 |

The bit was conducted with 8.5” and 6” diameter. This diameter are adjusted with the existing production casing and liner ( $9\frac{5}{8}$” and 7”). The remaining scale in the well because of diameter difference between the casing and the bit can be minimized by applying the jetting of drillling fluid.

**WHILE WORKOVER**

The workover program was started on July 19$^{th}$, 2013 and was ended on July 26$^{th}$, 2013. The total time required for this workover program was 177.5 hours, with 61.75 hours of non-productive time, which were 8.75 hours because of technical issues and 53 hours due to non-technical issues. The technical issues consisted of 2 hours for fishing stuck pipe and 6.75 hours for repairing the rig. The chart below is describing the total workover time required which are 5% of technical issues NPT, 30% of non-technical issues NPT, and the rest was the productive time.

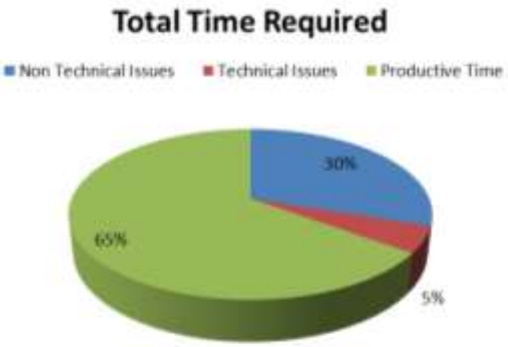


*Figure 5: Total Workover Time*

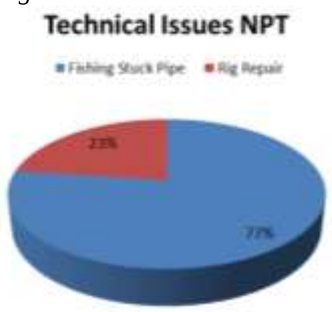


*Figure 6: Technical Issues NPT*

The main activities of the workover program are presented.

1. Quenching process. Quenching is the process that will make the wellhead pressure become zero. This activity is done to prevent a blow out from the well. The process of quenching activity were:
   a. Bleed the well until the lowest pressure that can be reached.
   b. Start to quench the well through the expansion spool wing valve with 0.5 L/s rate for two hours.
   c. Increase the rate of 0.5 L/s every 30 minutes until the rate of quench is 3 L/s rate.
   d. Bleed the well through another expansion spool wing valve and make sure that only gas that comes out from the valve. If it is difficult to bleed the gas through the wing valve, bleed the gas through the top valve.

e. Increase the rate of 1 L/s every 30 minutes until the total rate is 10 L/s.
f. Maintain this flow rate until the WHP reach 0 bar.
g. Change the rate becomes a gravitational rate and monitor the WHP 30 minutes after the WHP reach 0 bar.
h. Record the WHP every 15 minutes.

2. The master valve was opened by the company. The charge of workover program was started by this step.
3. After open the master valve, the next step was spud in the hole and then continued by run in hole the BHA and some drilling pipe, until it reached a tag.
4. After a tag had been reached, the next step was connecting the swivel and kelly to the drillpipe and start the circulation.
5. Milling and Reaming.
   Milling is a process to remove the scale in the wellbore with rotating the drillstring and give some WOB to the bit. Reaming is also a process to remove the scale with rotating the drillstirng but without giving some WOB to the bit. Another process of the drillstring in the well is washing down, that just circulate the fluid without milling or reaming.
6. Decision to POOH (Pull Out of Hole)
   There was some consideration to decide whether the drillstring need to be pulled out of the hole or not. First, when the bit reached the depth of TOL (Top of Liner), the bit is needed to be replaced with another bit with smaller diameter. If there is a problem that causes the lack of progress during drilling, the drillstring should be withdrawn and analyzed. Third, if the circulation of the mud is being stopped, the drillstring should be pulled.
7. The program could be stopped after the workover program reached the total loss circulation zone and finished by closing the master valve.

The summary of this workover activity is shown in Table 3.

From this operation, there were some hazard issue that had been found, which are:

1. Cutting disposal before the bit reached the total loss zone
2. Stuck of pipe because of bad hole cleaning after the bit reached the total loss zone.

In the perspective of production engineering, there was another issue that could be appeared, which is cutting remained at the bottom hole after the bit reached the total loss circulation zone. It’s different from the production well that the cuttings remained could be disposed by a horizontal discharge test before the well is connected into the system.

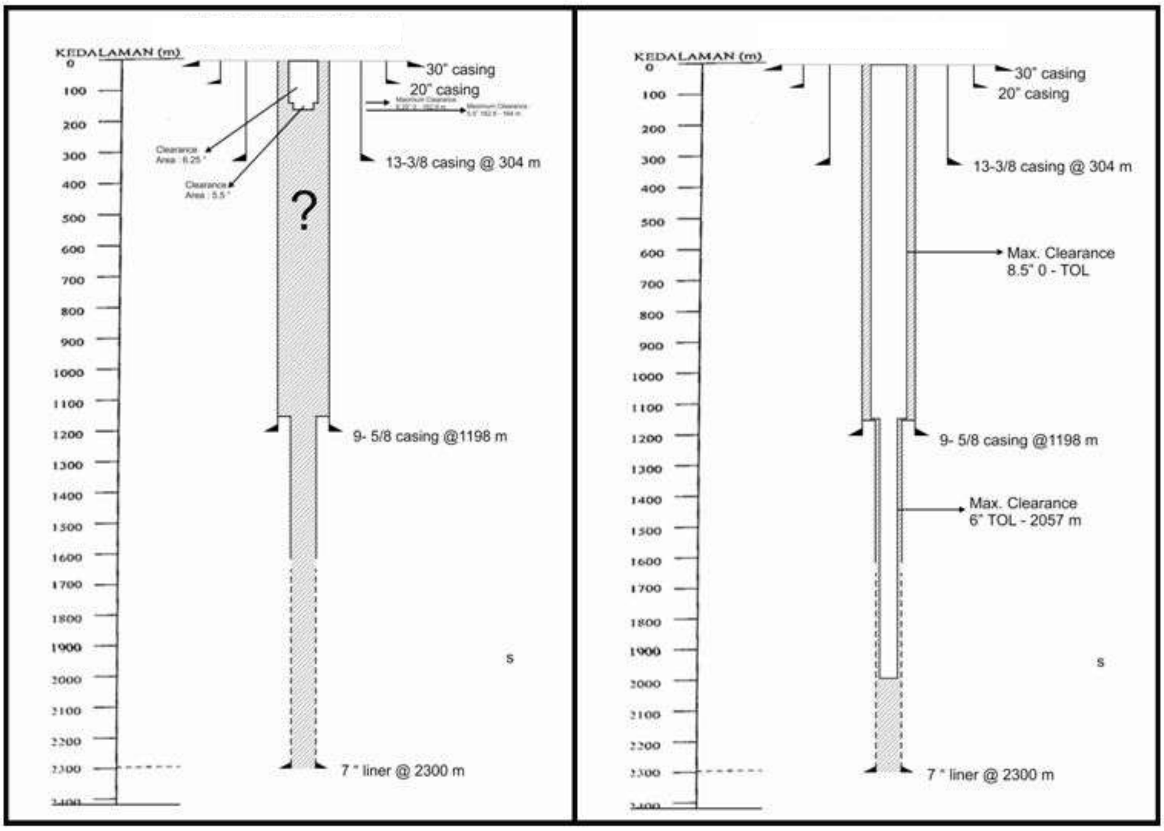


*Figure 7: Maximum clearance area of the well before the workover based on well investigation (left) and after the workover (right)*

*Table 3: Workover Activity Summary*

| BIT | No. | Description | | Start | End | Duration (hours) |
|---|---|---|---|---|---|---|
| 8.5" Type 1 | 1 | Run in Hole Process | Time RIH | 07:30:00 July 19th | 11:00:00 July 19th | 03:30:00 |
| | | | Depth (m) | 0.00 | 169 | 169 |
| | 2 | Milling, reaming, and or washing down process | Time | 11:00:00 July 19th | 14:30:00 July 20th | 27:30:00 |
| | | | Depth (m) | 169 | 1138 | 969 |
| | 3 | Pull out of hole process | POOH | 14:30:00 July 20th | 20:00:00 July 20th | 05:30:00 |
| 6" Type 2 | 1 | Run in Hole Process | Time RIH | 20:00:00 July 20th | 00:30:00 July 21st | 04:30:00 |
| | | | Depth (m) | 0 | 1138 | 1138 |
| | 2 | Milling, reaming, and or washing down process | Time | 00:30:00 July 21st | 10:00:00 July 21st | 09:30:00 |
| | | | Depth (m) | 1138 | 1375 | 237 |
| | 3 | Pull out of hole process | POOH | 10:00:00 July 21st | 21:00:00 July 21st | 11:00:00 |
| 6" Type 3 | 1 | Run in Hole Process | Time RIH | 21:00:00 July 21st | 02:00:00 July 22nd | 05:00:00 |
| | | | Depth (m) | 0 | 1375 | 1375 |
| | 2 | Milling, reaming, and or washing down process | Time | 02:00:00 July 22nd | 18:00:00 July 22nd | 16:00:00 |
| | | | Depth (m) | 1375 | 1904 | 529 |
| | 3 | Non Technical Issue | Non Technical Issue | 18:00:00 July 22nd | 20:00 July 24th | 50:00:00 |
| | | | Time RIH | 20:00:00 July 24th | 23:00 July 24th | 3:00:00 |
| | | | Depth (m) | 1139 | 1916 | 777 |
| | 4 | Milling, reaming, and or washing down process | Time Milling | 23:00:00 July 24th | 0:00 July 25th | 25:00:00 |
| | | | Depth (m) | 1916.00 | 2066.00 | 150.00 |
| | 5 | Pull out of hole process | POOH+Laydown | 00:00:00 July 25th | 15:00 July 26th | 15:00:00 |

Based on Table 3, the milling and reaming rates of penetration and rate of POOH and RIH are summarized below.

*Table 4: Rate of Penetration Summary*

| Bit | Process no. | ROP (m/hr) |
|---|---|---|
| 8.5” Type 1 | 2 | 35.23 |
| 6” Type 2 | 2 | 24.9 |
| 6” Type 3 | 4 | 33.0625 |

*Table 5: Rate of POOH Summary*

| Bit | Process no. | From Depth (m) | Rate (m/hr) |
|---|---|---|---|
| 8.5” Type 1 | 3 | 1138 | 284.5 |
| 6” Type 2 | 3 | 1375 | 196.42 |
| 6” Type 3 | 5 | 2066 | 138* |

*****POOH with rig lay down.

*Table 6: Rate of RIH Summary*

| Bit | Process no. | To Depth (m) | Rate (m/hr) |
|---|---|---|---|
| 8.5" Type 1 | 1 | 169 | 75.11 |
| 6" Type 2 | 1 | 1138 | 252.89 |
| 6" Type 3 | 1 | 1375 | 275 |

## AFTER WORKOVER

After this workover activity, the brine can be injected to the well with around 13 BPM rate in the circulation test before rig was lay down. The final result of the maximum clearance area of this workover program is shown in Figure 7 above. It's quite different with the well investigation result before the workover program was conducted, that also shown in that figure.

## IDEAS OF IMPROVEMENT

From all lessons learn that stated above, there are some recommendation to improve the result workover program, such as doing some wellbore investigation to have a baseline monitoring for this well. Other ideas for a work improvement are summarized below.

*Table 7: Ideas to improve the workover result.*

| No. | Problems | Recommendation |
|---|---|---|
| 1 | The Safety of the BOP | It's suggested to use double BOP with flexible pipe rams. |
| 2 | Remaining cutting | 1. Adjust the target depth, or<br>2. Use aerated fluid when the total loss circulation has been reached. |
| 3 | Stuck Pipe | 1. Enhance the standard of procedure (SOP) of workover operation while reaming, or<br>2. Use aerated fluid when the total loss circulation has been reached. |
| 4 | Wellbore & Reservoir Monitoring | See Figure 8.<br>Note:<br>It's recommended for doing a routine well investigation to get the baseline condition for each wells.<br><br>To get this monitoring result, the depth of the target must be change at least until the PLC/TLC/reservoir zone. |


*Figure 8: Instruction work flowchart for wellbore and reservoir monitoring.*

## REFERENCES

Boedihardi, M. et, al., (1991): "Evaluation of The Dieng Geothermal Field: Review of The Development Strategy", *Proceedings of Indonesian Petroleum Association*.

Calibugan, A.A., Wibowo, N. H., Harijoko, A. Wintolo, D., Tariela, M. R. B., Silitonga, T., Purwantoro, T., (2000), "Subsurface Geology and Hydrothermal Alteration in Dieng Geothermal Field, Central Java, Indonesia,", *3rd International Symposium Earth Resources and Geological Engineering Journal, 443.*

Layman, Erik. B. (2002), "The Dieng Geothermal Resorce, Central Java Indonesia," *Geothermal Resource Council Transaction*, 573-579.

Grant, M.A., I.G. Donaldson and P.F. Bixley, 1982: *Geothermal Reservoir Engineering.* Academic Press, New York, 369 pp.

Steingrímsson, B., and Gudmundsson, Á., 2006: "Geothermal Borehole Investigations During and After Drilling". *Proceedings of the "Workshop for Decision Makers on Geothermal Projects in Central America", organized by UNU-GTP and LaGeo, San Salvador, El Salvador,* 10 pp.

Steingrímsson, B. 2011: "Geothermal Well Logging: Cement Bond and Caliper Logs". *Presented at "Short Course on Geothermal Drilling, Resource Development and Power Plants",organized by UNU-GTP and LaGeo, in Santa Tecla, El Salvador*

Southon, J.N.A: *Geothermal Well Design, Construction and Failures*. Proceedings World Geothermal Congress 2005Antalya, Turkey, 24-29 April 2005.

**ATTACHMENT**

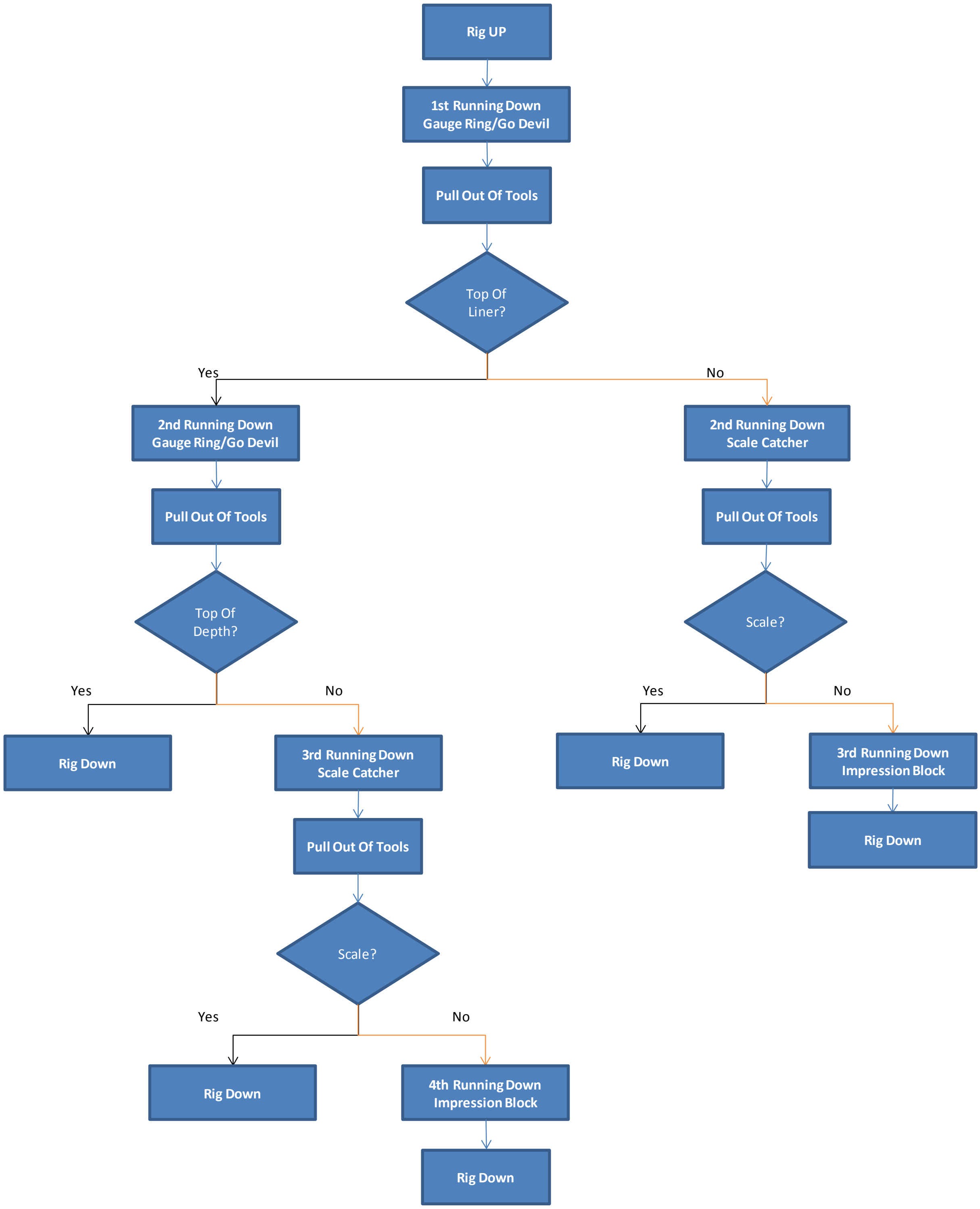


*Figure 2: Instruction Work Flowchart for Well Investigation*