Application of Wireline Fishing Tools and Techniques to Restore Well Production in Salak Geothermal Field, Indonesia

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ABSTRACT

AWI W-5 is one of biggest production wells in the Salak Geothermal Field. It was drilled to a total drilled depth of 9,560 ft. (2,914 m) MD in 2013 as a standard directional well with moderate inclination of 26°. The well was completed as a big hole with a 13-⅜" production casing and 8-⅝" perforated production liner. In March 2016, a dummy tool for a Pressure-Temperature-Spinner (PTS) survey was lost in-hole when it hit an obstruction at 1,645 ft. (~504 m) MD. AWI W-5 had to be throttled to prevent materials from the fish flowing to the surface and potentially damaging production facilities. A fishing job was organized in 2017 to retrieve the fish and fully open AWI W-5 into the system. By collaborating with PT. Expro Indonesia, a wireline fishing job was successfully executed and the well was put online with about 182 klbs/hr. (22.9 kg/s) of steam production. In this paper the authors describe the procedures used in executing the wireline fishing job and lessons learned, applicable to future fishing operations.

1. INTRODUCTION

1.1 Field overview

The Salak (aka Awibengkok) geothermal field is located 60 km south of Jakarta, West Java, Indonesia on the southwestern flank of the Gunung Salak volcano (2,211 m ASL) (See Figure 1). Currently, Salak is the largest producer of geothermal power (377 MWe) in Indonesia.

Commercial power generation at Salak began in 1994 with the installation of a 110 MWe plant (2 x 55 MWe or Units 1 and 2) operated by PLN. Production was increased to 330 MWe in 1997 with the addition of Unit 3, also operated by PLN and installed adjacent to Units 1 and 2, and Units 4, 5 and 6, operated by Star Energy Geothermal and installed at a separate location; Units 3, 4 5 and 6 are all 55 MWe plants. Generation was increased to 377 MWe in Generation was increased to 377 MWe during 2002-2004 when the turbines were uprated.

Salak is a liquid-dominated geothermal system with a moderate- to high-temperature (464°-600°F / 240-316°C) fracture-controlled reservoir hosting benign and low to moderate non-condensable gas (NCG) fluids. The reservoir is contained within a sequence of volcanic rocks of predominantly andesitic to rhyodacitic composition with a basement of Miocene marine sedimentary rocks; both volcanic and sedimentary rocks are cut by igneous intrusions.

With a current installed capacity of 377 MWe and a proven reservoir area of about 18 km^2 (Figure 2), the Salak field has a power density of about 21 MWe/km^2. To maintain full generation, the field operators have undertaken periodic drilling of make-up wells, realigning its injection system, and conducting well workovers. The most recent make-up well drilling campaign was in 2012-2013 while the last workover campaign was in 2017.

Figure 1: Map of West Java showing Awibengkok/Salak and Darajat contract areas.

1.2 Well overview

AWI W-5 was drilled in 2013 as a standard directional well with moderate inclination of 26° to a total depth of 9,560 ft.MD (2,194 m). The well was drilled as a production well targeting the relatively undrilled high-temperature liquid reservoir located west-southwest of the AWI W pad. The well was completed as a big hole with a 13-⅜" production casing and 8-⅝" perforated production liner (Figure 2). The well could produce 180-260 klbs/hr. (22.6 – 32.7 kg/s) of steam at 114-117 psig Flowing Well Head Pressure (FWHP), which makes the well one of the biggest producers in Salak Geothermal Field.

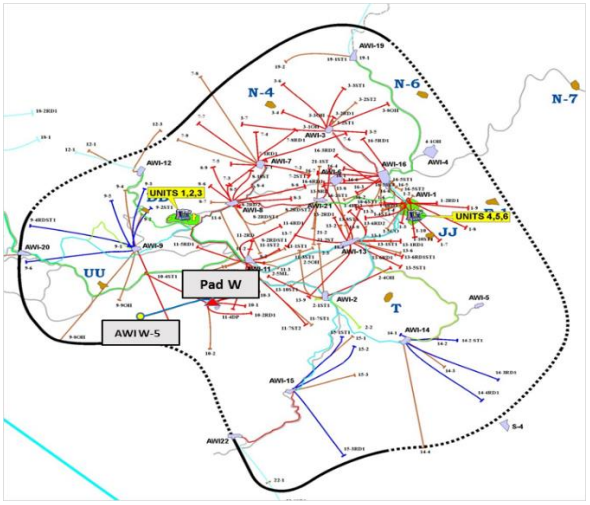
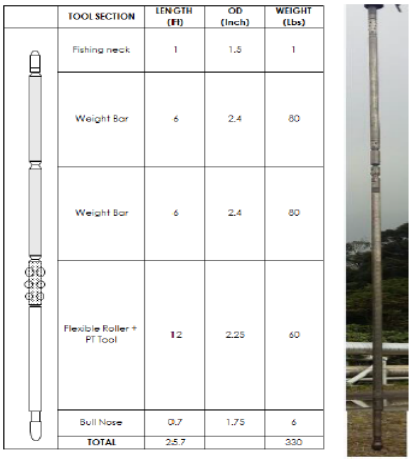


Figure 2: Map of Salak field show AWI W Pad and AWI W-5 wells.

During routine surveillance logging job in March 2016, a dummy tool for Pressure Temperature Spinner survey was run in-hole but hit an obstruction at 1,645 ft. (501 m) MD. After several runs the dummy tool got stuck at the same depth. Attempts were made to release the dummy tool with the tension-release method, up to 1800 lb tension but the dummy tool could not be released. Then, the tool was left overnight with the cable under tension. However, next day, it was found that the cable had been unintentionally cut at the tee which caused the tool and cable to be left in-hole.

In July 2016, a caliper survey was supposed to be conducted but was canceled when the dummy caliper tool snagged about 157 ft. (48 m) of cable near the surface. The cable came from the fish left in-hole in March 2016. The remaining fish left in-hole is estimated to be ~1,500 ft. (457 m) of e-line cable and 25 ft. (~8 m) of the dummy tool (Figure 3). The following parts of the fish were left in-hole:

- Approximately 1500 ft (457 m) of e-line.
- Weight bar total 12 ft (3.6 m).
- Flexible roller and PT Tool total 12 ft (3.6 m).
- Bullnose



TOOL SECTION	LENGTH (FT)	OD (Inch)	WEIGHT (Lbs)
Fishing neck	1	1.5	1
Weight Bar	6	2.4	80
Weight Bar	6	2.4	80
Flexible Roller + PT Tool	12	2.25	60
Bull Nose	0.7	1.75	6
TOTAL	25.7		330

Figure 3: Fish left in hole information.

With the fish in-hole, AWI W-5 was throttled to 50% of its normal operating setting. Eventually, the well was shut-in to prevent any parts of the fish from flowing to the surface and potentially damage production facilities.

1.3 Fishing Program Maturation

During the 2017 Salak Workover Campaign, the AWI W-5 fishing job was included in the campaign to recover the steam production from the well. The Workover Team decided to conduct the fishing job using a wireline; the back-up plan was to use a Hydraulic Workover Unit (HWU) for the fishing job. The three main reason why the project team selected wireline fishing job rather than fishing with HWU: it is cheaper, it can be executed as per schedule and with proper well control equipment.

An assessment of the details and associated risks of the fishing program was conducted in collaboration with a third-party service business partner, PT. Expro Indonesia. This collaboration resulted in the decision to use the Expro's Slickline Heavy Duty Fishing Unit (HDFU). Among others, the Slickline HDFU can pull up to 8,000 lbs; it can be easily rigged up and down using an appropriately sized crane; it uses various types of heavy duty fishing tools; and can attach three types of safety devices (if the tool gets stuck or cannot be released).

Other topics discussed during the collaboration with PT. Expro Indonesia included the required well control equipment and configuration during the fishing job, a contingency plan if the size of the fish is bigger than the size of the Blow-Out Preventer (BOP), the use of the Management of Change (MOC) process should be there for any deviations in the agreed plan. Below are the general procedures developed for the fishing job using the wireline:

- Preparation
  - Ensure all supporting tools and equipment are available and has been pressure tested prior to installation.
  - Well quenching and vacuum test.
  - Install secondary master valve (MV) and Pressure Control Equipment (PCE) then pressure test. See Figure 4 for PCE stack.
- Rig-up and run in-hole the 6" impression block with the Wire Finder and tag the top of fish (TOF) (Figure 5).
- Rig-up and run in-hole the 7" Wire Finder with the 4.2" Wire Grab (Figure 6) to catch the wire/fish and pull out to surface.
- Rig-up and run in-hole the 6" impression block with the Wire Finder and tag the top of fish (TOF).
- Rig-up and run in-hole the overshoot to latch on tool fishing neck and pull out of hole.
- Rig down BOP, lubricator and secondary master valve. Demobilize all the equipment.

2. FISHING JOB OPERATION

Fishing job started on July 20, 2017. Up to completion of the job, a total of 42 fishing tool runs were conducted using various configuration of fishing tool. The following is a summary of fishing job operation to achieve project objectives:

- Well preparation, behaviour monitoring and pressure testing
  - Pressure test all the equipment as per the fishing program; quench the well and monitor well behaviour.
  - Found anomalous well behaviour when a fluid column built-up over the obstruction that limited the fluid going down to the bottom of the wellbore and created "vacuum" condition in the well. This condition prevented us from doing continuous injection during the fishing job (see Figure 7).

- Develop MOC to assess risk and safe guards for the fishing operation without continuous injection and obtain approval from the authorized approver.

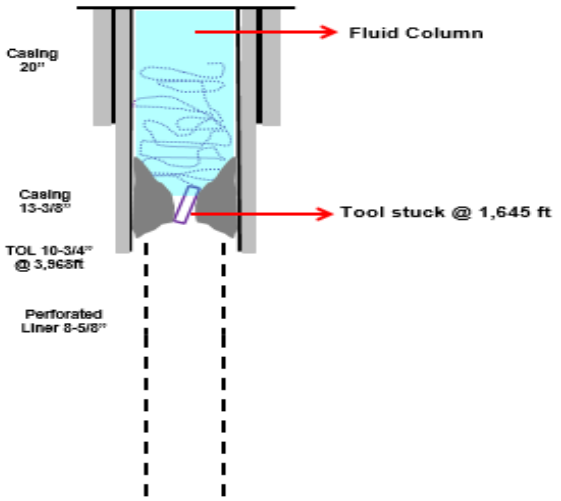


Figure 7: Illustration of wellbore condition during quenching

- First fish recovery
  - Rigged up and run in-hole for multiple times various configuration of fishing tools such as impression block, wire finder, wire grab, pulling tool and bell guide until we successfully retrieved the e-line cable for the first time. Estimated e-line cable recovery was about ~516 ft (157.2 m) based on a weight measurement.
  - During the early attempts to fish the wire, the 7" bell guide was stopped at the x-over 12" x 7" above the secondary MV because internal diameter (ID) of the x-over is exactly 7". We modified the x-over to a bigger ID size to allow the fishing job to continue.
  - An important lesson learned from the above is that is necessary to ensure that the OD of all fishing tools and ID of all components of the wellbore equipment are appropriate.
- Second fish recovery
  - Continue to be rigged up and run in-hole several times various configurations of fishing tools (impression block, wire finder, wire grab, pulling tool and bell guide) until we successfully retrieved e-line cable for the second time. Estimated e-line cable recovery was about ~645 ft (196.5 m) based on a weight measurement.
  - During the fishing operation we modified the bell guide from 7" to 11.8" to make it easier for the fishing tool to retrieve the fish inside 13-3/8" casing.
  - Develop MOC to assess risk and safe guards for the fishing operation using an 11.8" bell guide and open-hole conditions when pulling out the fish. Obtained approval from the authorized approver.

In the last run of the impression block, we tagged the obstruction at 1,677 ft (511 m) and found a scale mark instead of a cable or tool mark.

The fishing job using the Slickline HDFU, in total, pulled out 1,161 ft. (~354 m) of fish from inside AWI W-5 (see Figure 8). Including the e-line cable retrieved at the surface previously, about 1,318 ft. (~402 m) of fish was recovered.

Based on the latest impression block profile, it can be inferred that the dummy tool's position must be below the obstruction at 1,677 ft (511 m) or possibly, it could have dropped to the bottom of the wellbore, together with the remaining e-line cable (if any).

AWI W-5 was put back into the system after the workover and produced 182 klbs/hr. (22.9 kg/s) of steam at 130 psig FWHP

3. CONCLUSION

A fishing job using a heavy duty wireline was safely and successfully executed to retrieve a fish composed of e-line cable and a dummy tool assembly at Salak Field. Although the fishing job required multiple runs with various fishing tools, the collaboration between Star Energy, which has knowledge of the well, and PT. Expro, which has fishing expertise, was a classic example of the value of jointly planning a complicated operation. A fishing job is an "art" and more information about the condition of the well and the fish increases the probability of its success. Wireline fishing, which is generally cheaper and faster to implement, should be considered as an alternative to rig/HWU or CTU-conveyed fishing jobs.

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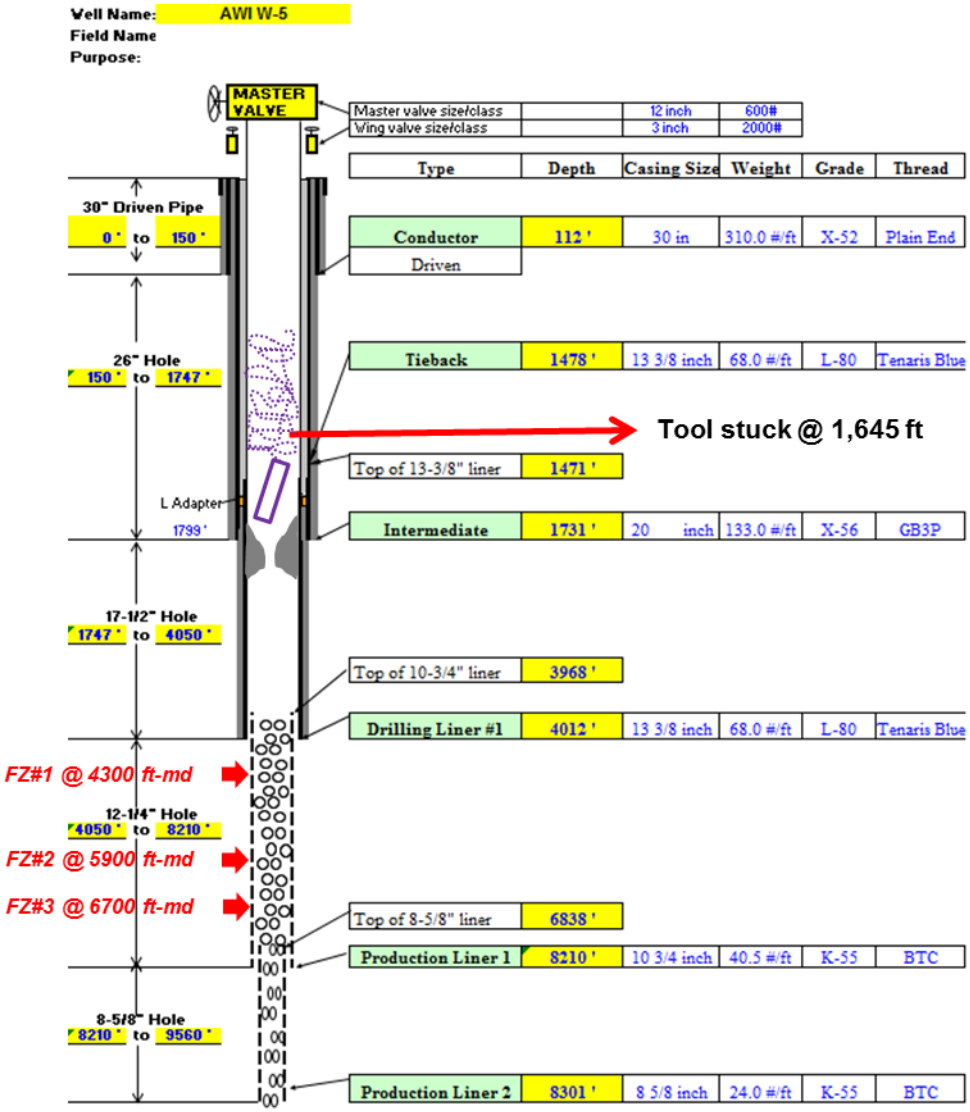

Figure 3: Diagram showing the AWI W-5 well schematics.

-Grease injection head

Will fit with 7/32" – 5/16" cable size

-Lubricator

Will using 7" ID PCE (please see attachment for PCE schematic)

-Quick test Sub

As place to open and close PCE connection when changes the tool

Pressure test will apply to QTS every time we disconnect and connect the PCE safe time for Pressure test whole assembly of PCE

-Dual Hydraulic BOP

Using double rams with lower rams inverted so will still holding the pressure when cable inside the BOP

-Pump Tee

As a line to surface line

-Well head X over

Figure 4: Schematic diagram of the Slickline HDFU Pressure Control Equipment (PCE) stack.

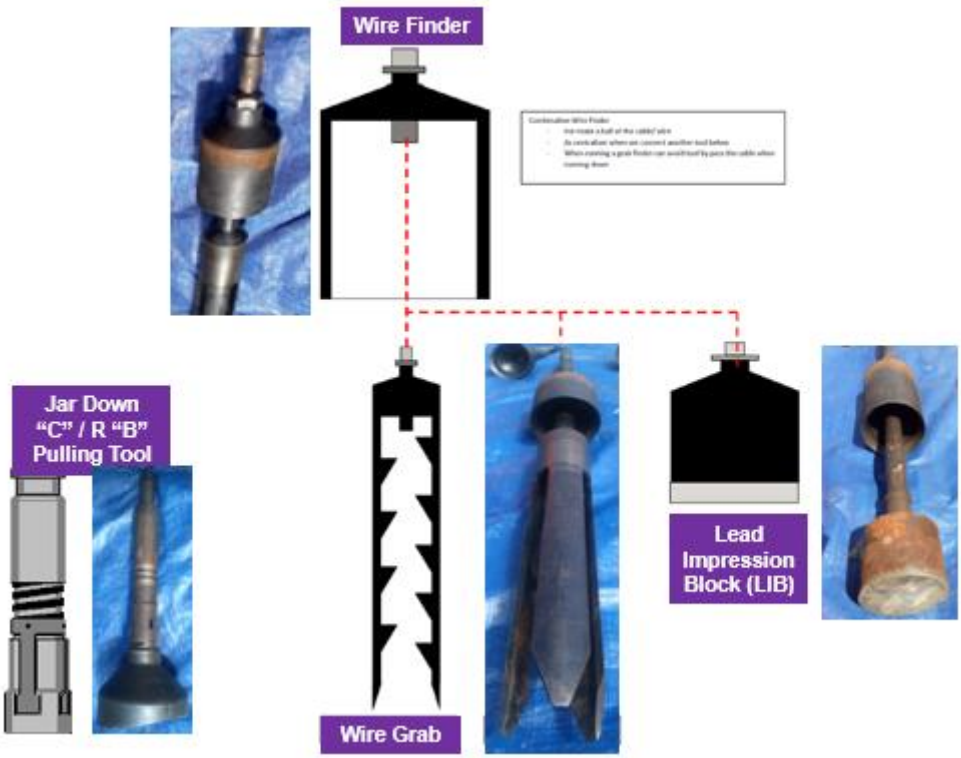

Figure 5: Fishing tools used during the wireline fishing job at AWI W-5.

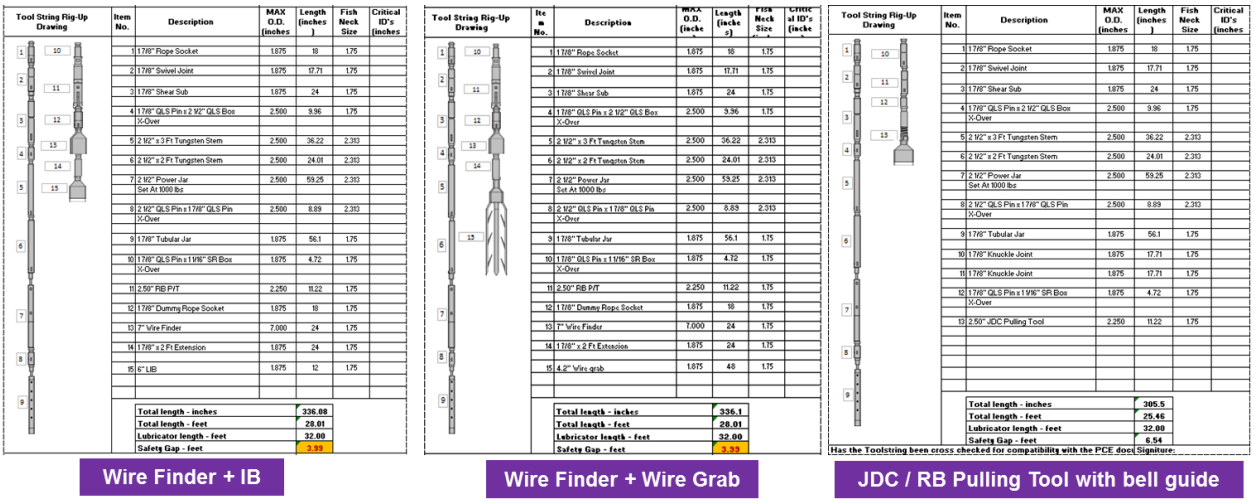

Figure 6: Schematics of the Slickline HDFU wireline fishing tool assembly.

Figure 8: Recovered fish wire at the surface and IB mark at 1,677 ft.