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DAMAGED WELLHEAD REHABILITATION OF WELL OK-5 SOUTHERN NEGROS GEOTHERMAL PRODUCTION FIELD, NEGROS ORIENTAL, PHILIPPINES

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ABSTRACT

Corrosion and silica deposition, aside from normal wear and tear, are the main causes of repair and replacement of major equipment in the geothermal plant's fluid collection and disposal system (FCDS) like pipelines, valves, and other accessories. In the Philippines, most geothermal fields are located in mountainous, rugged terrain and coupled with the regular visits of typhoons bringing with it heavy precipitation create favorable conditions for landslides.

A major landslide with an estimated volume of 50,000 cubic meters occurred on October 23, 1998 that hit the Wells OK 5 and BL 2D in Palinpinon I production field. The debris devastated the wells and its pipelines. The wellhead tee of Well OK 5 was sheared-off above the master valve and the well discharged at fullbore to the atmosphere.

The task of the wellhead rehabilitation faced a number of physical obstacles. But the true challenge was on "taming the wild well" so that repair of the sheared-off tee, the cracked anchor casing, and replacement of the master valve could follow. Teamwork and the years of experience contributed to the success of the well rehabilitation. The rehabilitation took 6 ½ months and Php 30 million charged to insurance.

1.0 INTRODUCTION

The Southern Negros Geothermal Production Field (SNGPF) has been in production since June 1983 with the commissioning of the Palinpinon I Fluid Collection and Disposal System (FCDS) supplying steam to the 112.5 MWe Palinpinon I Geothermal Power Plant of the National Power Corporation in Valencia, Negros Oriental, Philippines. In its 20 years of operation, geothermal steam supply activity was continuously conducted without any major problems. And in the early 1990's, the steam availability was expanded with the construction of the Palinpinon II FCDS in three separate areas in Okoy 5, Nasuji, and Sogongon, a few kilometers to the west of Palinpinon I FCDS. The Palinpinon II FCDS supplies the steam requirement of the modular plants of the National Power Corporation with a total capacity of 80 MWe.

The Okoy 5 FCDS was commissioned in 1994 with three production wells OK-5, BL-1D, and BL-2D located in a pad cut along a rugged terrain. Such pad location poses a high risk in terms of land/rock slides. Right above the said pad is a high and almost vertical slope of cracked rock and soil formation. Well Okoy 5 was the first well drilled in this pad as part of the exploratory phase. However, considering the limited space available for drilling sites, said pad was maximized later in the development stage and two other production wells were directionally drilled. In order to address the risk of landslides damaging the facility and interruption of the steam supply operation, PNOC-EDC applied for insurance coverage on the pipelines and other equipment including its business interruption. Steam supply operations of the Okoy 5 FCDS went smoothly until one day its pad was covered almost entirely by a massive landslide after a strong typhoon with heavy rains on October 23, 1998. The wellhead of production well OK-5 was completely covered with debris and steam was uncontrollably discharging. The two-phase lines and steamlines were likewise hit, carried away by the debris and likewise severely damaged. And steam supply to the modular power plant was then stopped while repairs and corrective actions were being done on the damaged facilities.

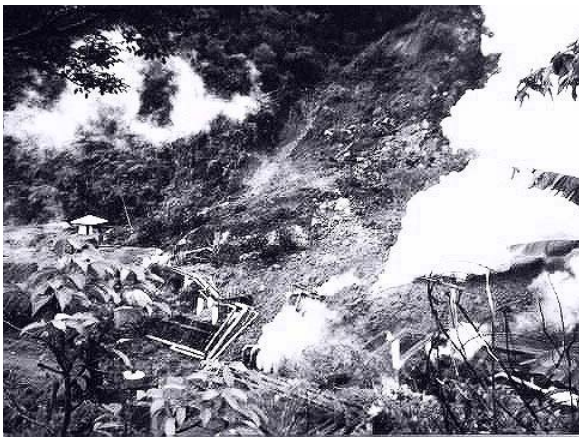

Figure 1. The landslide

Figure 2. The damage on the wellhead of OK 5.

2.0 THE WELL OK-5

Well OK-5 was drilled on October 20, 1978 as an exploratory production well located in rugged terrain. Though it was not the first well to successfully discharge, it was the first commercially viable well in Palinpinon-I with an initial output of 8.4 MWe with an enthalpy of 2200 kJ/kg and mass flow of 23 kg/sec. It ushered the construction and commissioning of the field's first 1.5 MWe pilot plant in September 1980 proving the viability of the resource. The pilot plant was later mothballed in May 1994 and usage of the well ceased. The well currently supplies the new 20 MWe OK 5 Modular Power Plant with an output of 9.0 MWe and has been continuously supplying the plant in parallel with wells BL-1D and BL-2D. BL-1D was later replaced by BL-3D.

3.0 THE LANDSLIDE

On October 23, 1998 during the height of a typhoon, a massive landslide with an estimated volume of about 50,000 cubic meters (Bien, 1999) engulfed the production well pad and damaged the wellhead. The landslide occurred right after a period of intense rainfall. Post landslide analyses revealed that heavy rainfall, steep slopes, loose soil and the presence of a plane of weakness provided by an unmapped fault contributed to the triggering of the landslide (Bien, 1999). The modular plant was immediately put on house load that day and shutdown after 4 hours with PNOC-EDC invoking force majeure (Quevenco, 1998). Debris totally covered the production pipelines and wells OK-5 and BL-2D. Well OK-5 was discharging uncontrollably through the debris (Figure 1). Access and mobility in and around the site was limited due to the muddy debris. Clearing of the debris was necessary before damage assessment could be conducted. It took 28 days to partially clear the production well pad to allow closer inspection of the damage. Slope stabilization was also necessary to ensure the safety of personnel working in the area. The plant was immediately put on shutdown and PNOC-EDC invoked Force Majeure as provided for in the Steam Sales Contract with the National Power Corporation (NPC). With this provision, overrides the 75% Guaranteed Generation provision in the Contract and PNOC-EDC was not liable to pay any charges to NPC throughout the 6 ½ month rehabilitation period.

4.0 EXTENT OF DAMAGE

Damage assessment on OK 5 revealed the following:

- The wellhead 10" tee above the master valve was completely sheared-off at the flange neck weldment (fullbore discharge to atmosphere) (Figure 2).

- The weldment between the CHF and the 13-3/8" anchor casing was partially sheared with an opening of about 1" (minimal steam leak).

- The wellhead components from the CHF up to the master valve were held in place only by the 9-5/8" production casing.

- The whole wellhead was tilted at about 37 degrees and resting on the cellar wall.

- The master valve stem was bent approximately 5 degrees (it was not possible to operate the valve).

- All associated pipelines and wellhead equipment were damaged hampering the steam supply to the Modular power plant.

5.0 OPTIONS AND OBSTACLES

Prior to any rehabilitation of the wellhead and its associated lines, it was necessary to repair the strong leak discharging two-phase fluid. A number of options for the wellhead repair were contemplated taking into consideration cost, duration, environmental impact, and safety to personnel. Isolating the "wild well" might have been done possibly by drilling at the side of the well and plugging it with cement. However, this procedure would entail high costs, longer time for rig mobilization, and redrilling of the well. It was decided that the repair of the leak of damaged wellhead would be done at "hot" condition so that quenching of the well would commence and well rehabilitation could proceed.

The major obstacles encountered were as follows (Dela Cruz, 1999):

- The noise level was intense and communication was possible only through hand signal or written notes (Figure 3).

- Rainy weather made the surrounding soil muddy slowing down mobility around the wellhead.

- There was poor visibility due to the presence of escaping steam in the wellhead cellar making welding difficult.

- Movement of the 9-5/8" casing when the well was quenched.

6.0 SUCCESSFUL REPAIR

The first objective was to gain access to the master valve to have a clear assessment of the damage. The steam leak was diverted away from the target area to allow personnel to work at the specific part of the wellhead where there was leak. The master valve stem was straightened to allow operation of the said valve. With the master valve shut, quenching of the well commenced by pumping water through the break in the 13-3/8" anchor casing.

Figure 3. Physical factors that increased the risk and slowed down the task: noise, heat, mud, and steam.

With continuous water injection, the master valve and expansion spool was removed. The CHF was also removed by cutting-off the anchor casing at 1.0 meter below the CHF. A leak at the anchor casing reduced the flow rate of injected water and almost initiated a blow-out. The leak was eventually stopped and repairs continued. The new CHF was installed and finally the master valve was put in place on December 31, 1998 at 9:15 p.m. Highly skilled welders were contracted to weld the casings at hot condition. Complete rehabilitation proceeded in next 5 months – replacement of production lines, wellhead supports, and other accessories. Force majeure was lifted by PNOC-EDC on May 7, 1999 (Quevenco, 1999). Total rehabilitation took 6 ½ months.

7.0 ENVIRONMENTAL IMPACT

Nearby vegetation like abaca temporarily withered and defoliated caused by the uncontrolled discharge from Well OK-5 and recovered after a few months (Mago, 1999). No significant detrimental impact (Boron level) was observed on the water quality. H2S levels were below the 10 ppm Work Area Standard. Noise

level was at 118 dBa and personnel had to wear ear mufflers within 50-meter radius.

8.0 TEAM EFFORT AND EXPERIENCE

PNOC-EDC management commended the SNGPF team for the successful restoration that was initially thought to be impossible to do (Javellana, 1999, PNOC-EDC Internal memo). The success can be attributed to proper planning, teamwork, dedication of the men and women, and the years of experience. The rehabilitation cost amounted to Php 30M with no lost-time accidents (pers. comm. Catacutan, 2003). . However, PNOC-EDC estimated it incurred a business opportunity loss in the figure of about Php 72 million (Energy Times, Feb. 2000 issue, PNOC publication).

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