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Damaged Wellhead Rehabilitation Well OK-5, Southern Negros Geothermal Production Field, Negros Oriental, Philippines

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ABSTRACT

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 that create favorable conditions for landslides to occur.

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

The task of the wellhead rehabilitation faced a number of physical obstacles like unfavorable weather condition, noise due to the discharge, mud, and steam venting from the cracked casings. A major challenge was on "taming" the " wild well" to access the wellhead cellar and replacement could be done on the sheared-off tee, cracked anchor casing and production casings, and master valve. 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 business interruption insurance.

1.0 INTRODUCTION

The Southern Negros Geothermal Production Field (SNGPF), located in Negros Island, Central Philippines, has been in production since June 1983 with the commissioning of the Palinpinon I Fluid Collection and Recycling System (FCRS) supplying steam to the 112.5 MWe Palinpinon I Geothermal Power Plant of the state-owned National Power Corporation (NPC) in Valencia, Negros Oriental, Philippines. Now on its 21st year of operation, geothermal steam was continuously supplied without any major problems. In the early 1990's, the steam availability was expanded with the construction of the Palinpinon II FCRS in three separate areas in Okoy 5, Nasuji, and Sogongon, a few kilometers to the west of Palinpinon I FCRS. The Palinpinon II FCRS supplies the steam requirement of the 3 modular plants of the National Power Corporation with a total capacity of 80 MWe.

The Okoy 5 FCRS and the 20 MWe OK5 Modular Plant was commissioned in 1994 with three production wells OK-5, BL-1D, and BL-2D located in a production well 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. See Figure 1 below. 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, two additional directional production wells (wells BL-1D and BL-2D) were drilled on the said pad during the development stage. 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 FCRS went smoothly until October 23, 1998. A massive landslide occurred after a period of heavy rainfall brought about by a typhoon devastated almost entirely the wells and pipelines. 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 debris, and severely damaged beyond repair. Steam supply to the modular power plant was shutdown to allow emergency corrective actions and repair on the damaged wells and related equipment (Omandam, 1998).

Figure 1: The Well OK5 Wellhead Pad

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 in 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 the said well currently supplies the new 20 MWe OK 5 Modular Plant owned and operated by NPC. The well currently has an output of 9.0 MWe and continuously supplies the plant in parallel with wells BL-2D and BL-3D. BL-1D is a reserve well.

Figure 2: The Landslide

3.0 THE LANDSLIDE

On October 23, 1998 during the height of a typhoon, a massive landslide with an estimated volume of debris 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 slope, loose soil and the presence of a plane of weakness provided by an unmapped fault contributed triggered the landslide (Bien, 1999). The modular plant was immediately put on house load that day and was shutdown after 4 hours when PNOC-EDC invoked Force Majeure (Quevenco, 1998). Debris totally covered the production pipelines and wells OK-5 and BL-2D. Well OK-5 discharged uncontrollably through the debris at fullbore discharge to the atmosphere. See Figure 2. Access and mobility in and around the site was limited due to the muddy debris. Clearing of the debris was necessary before damage assessment can 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 (Diamante, 1998). The power plant, operated by the state-owned National Power Corporation (NPC), was immediately put on shutdown when PNOC-EDC invoked Force Majeure as provided for in the Steam Sales Contract. With this provision, it overrides the 75% Guaranteed Generation provision in the Contract and PNOC-EDC, the steam supplier, was not liable to pay any charges to NPC on generation losses throughout the 6½-month rehabilitation period.

4.0 EXTENT OF DAMAGE

Damage assessment on OK 5 revealed the following: (Tilos,1999)

The wellhead 10” tee above the master valve was completely sheared-off at the flange neck weldment and the well was discharging fullbore to atmosphere.

The weldment between the CHF and the 13 3/8” anchor casing was partially sheared with an opening of about 1” resulting in a minimal leak of steam at the area.

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. See Figure 3 below.

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

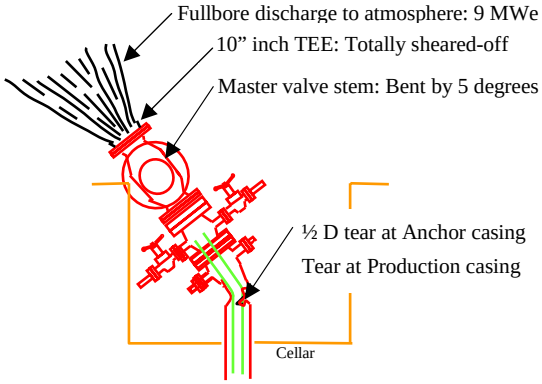

Figure 3: Extent of damage on the wellhead

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 considered 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)

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

(2) Rainy weather made the surrounding soil muddy slowing down mobility around the wellhead.

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

(4) Movement of the 9 5/8” casing when the well was quenched.

Figure 4: Steam, heat, and noise around the work area

6.0 SUCCESSFUL REPAIR

The first objective was to gain access to the area in and around 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 bent master valve stem was straightened to allow operation of the said valve.

Figure 5: The Rehabilitated Well OK5

With the master valve shut, quenching of the well commenced by pumping water through the break in the 13 3/8" anchor casing. With continuous water injection, the master valve and expansion spool were 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 repair 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 hired to weld the casings at hot condition. Complete rehabilitation proceeded in next 5 months – replacement of production lines, wellhead supports, and other accessories (Guillen, 1999). Force majeure was lifted by PNOC-EDC on May 7, 1999 (Quevenco, 1999) ending the 6½- month rehabilitation period.

7.0 ENVIRONMENTAL IMPACT

Nearby vegetation mostly abaca temporarily withered and defoliated caused by the uncontrolled discharge from Well OK-5 but recovered after a few months after the discharge (Mago, 1999). No significant detrimental impact was observed in the Okoy river water quality (Boron level). Measured H2S levels were below the 10 ppm level 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).

REFERENCES

Dela Cruz, GP Jan. 26, 1999. OK-5 Wellhead Rehabilitation

Bien, Oscar C. March 31, 1999. Report on OK-5 Landslide Risk Assessment

Tilos, R.E. February 4, 1999. OK-5 Wellhead Rehabilitation Report II

Diamante, N.B. Dec. 10, 1998. Internal PNOC-EDC memo "OK-5 Wellhead repair update"

Quevenco, Jesus M., Jr. Oct. 23, 1998. PNOC-EDC Memo to National Power Corp. "OK-5 Shutdown due to Force Majeure"

Mago, Leo Z. A. 1999. PNOC-EDC Internal memo "OK-5 Landslide Area Monitoring Report"

Duran, E.V./ Zerna M.D. Jan. 8, 1999. PNOC-EDC Internal Report on "Statement of charges for Utilization of Rig equipment"

Javellana, S.P. Jan. 7, 1999. Okoy 5 Wellhead Restoration"

Omandam, V.D. Dec. 1, 1998. PNOC-EDC Internal memo "OK-5 Plant Shutdown"

Guillen, H. V. May 31, 1999. PNOC-EDC Internal memo "Okoy-5 FCRS"

Energy Times, February 1999 issue, "Strength in the face danger, the P1PF experience", PNOC Publication

Catacutan, C.R. January 2003. pers. comm.