Proc. 12th New Zealand Geothermal Workshop 1990

TARAWERA ORMAT INSTALLATION. UNATTENDED MODULAR GEOTHERMAL POWER PLANT PERFORMANCE REPORT

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SUMMARY

In the following report, the authors focus their attention on the performances of the Tarawera Ormat Installation (TOI) Power Plant. This review is based on information gathered through the remote monitoring and diagnostic system and on infomation supplied by the power plant operators during a period of several months. In the first part of this review, the actual performance of the power plant will be compared with the design point performance. In the second part, the achieved performance and the remote monitoring capacity will be described and analyzed.

The Geothermal Power Plant at Tarawera is the latest geothermal development in New Zealand, and the first dedicated power station in New Zealand to use geothermal energy apart from those owned by Elecmcorp. Figure 1 gives the geographic area of the Tarawera Ormat Installation. Although the scale of the TOI plant is substantially smaller than the other geothermal installation in New Zealand, its technical, commercial and environmental significance is out of all proportion to its size.

Technical, because it uses a wasted geothermal resource obtained of a natural resource to generate electrical power for use in the local community.

Commercial, because, contrary to the scaling down effect of a conventional industrial facility, the TOI power plant is a cost effective installation. The power plant designers and constructors managed to maintain an installed price per kilowatt within the planned budget, while achieving a record construction time of 15 months from purchase award day.

Environmental, because there is no gas emission from this power plant, its generated noise is well within acceptable limits and its visual impact is more than modest.

Figure 2 shows a general view of the TOI Power Plant.

TOI DESIGN APPROACH

The TOI Power Plant has an installed capacity of 2.6 MW and is situated at the separator station KA21 at Tarawera.

The binary cycle geothermal power plant receives heat from hot geothermal water separated from the geothermal fluid of Well KA21 and uses a closed Rankine cycle to convert the heat to electrical power.

The working fluid for the Rankine cycle is a hydrocarbon.

Heat rejection from the power plant is accomplished with a forced air air condenser positioned on the top of the OEC units.

Table No. 1 summarizes the technical specifications of the OEC units, giving the various data at the power plant design point.

Figure 3 gives a graphic display of OEC 1 as it was recorded through the remote monitoring system at manufacturer's facility, on August 26, 1990 at 12:32:47 pm.

As can be seen, the actual data is within the range of measurement tolerance of the design performance with one exception - **the actual performance of OEC 1 is approximately 5% higher than its design point.**

TABLE 1: TECHNICAL SPECIFICATIONS PER OEC UNIT AT DESIGN POINT

1. OEC Performance	
Number of OEC units:	2
Gross output per OEC:	1250kW
Internal OEC auxiliaries including air condenser fans.	
Total net output*:	2100 kW
1.2 Hot Side Data:	Separated geothermal
OEC heating media	pressurized hot water
Total flowrate:	74 kg/sec
Temperature/pressure inlet to OEC vaporizer/ preheater	172°C/8 bar
Temperature outlet from preheater/vaporizer:	110°C
Heat input per OEC:	9.1 MW
2.3 Cooling Side Data	
Cooling media:	Ambient air
Air mass flow:	1 141 000 kg/h
Air temperature at design point inlet:	14°C
outlet:	36°C
2.4 Turbine	
Turbinetype:	Specially designed impulse type
Rotation speed:	3015 rpm
2.5 Generator	
Rated voltage:	660 V/3 phase
Frequency:	50 Hz
Type:	Induction
Rotational speed at full load:	3015 rpm

*The power output is given at design point condition and clean heat exchanger

Figure 4 gives a graphic display of the TOI power plant as recorded on the same day. The total generated power is 2,553 kW. Approximately 353 kW are used by the power plant utilities fans, pumps, etc). Therefore, on August 26, 1990 at 12:32:47 pm 2,200 kW were actually fed into the grid of the Bay of Plenty Electricity.

Following 8 months of weekly monitoring of the power plant data, the following conclusions can be drawn:

The geothermal hot water supply is constant in its flow and its temperature and is equivalent to the assumed data in the power plant design criteria.

The ambient air temperature as measured at units 1 and 2 oscillate according to an expected curve (see Figure 5).

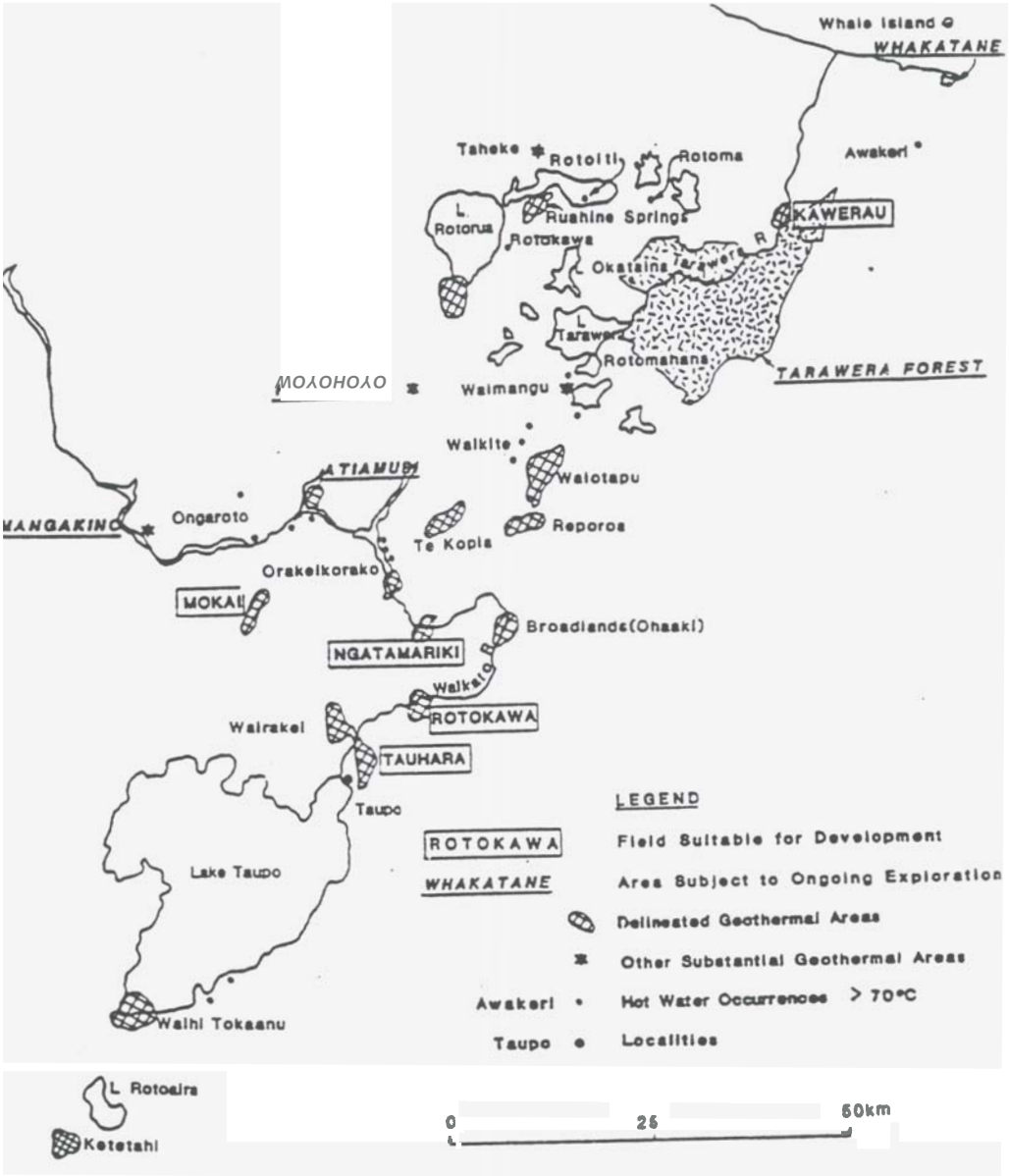
According to the heat balance calculations carried out, and proved by the actual electricity generated, it appears that the silica deposition on the heat exchanger surface is negligible. (In fact, this was predicted in a study made by a professional engineer and by the equipment manufacturer prior to installation).

Having relative constant heat input, a predicted ambient temperature oscillation and no disturbances caused by the chemistry of the geothermal water, the power plant generation capacity and its overall availability is dependent on 3 major factors:

(a) the availability of the geothermal fluid:
(b) the quality of the O & M personnel of the power plant; and
(c) the quality of the generating equipment.

As can be seen in Figure 3, OEC No. 1 had an operating record on August 26 at 12:32:47 of 5,643 hours. Taking into account the fact that the power plant had started its commercial operation on December 24, 1989, an overall availability of 96.6% can be shown. This is an excellent performance without any additional comments.

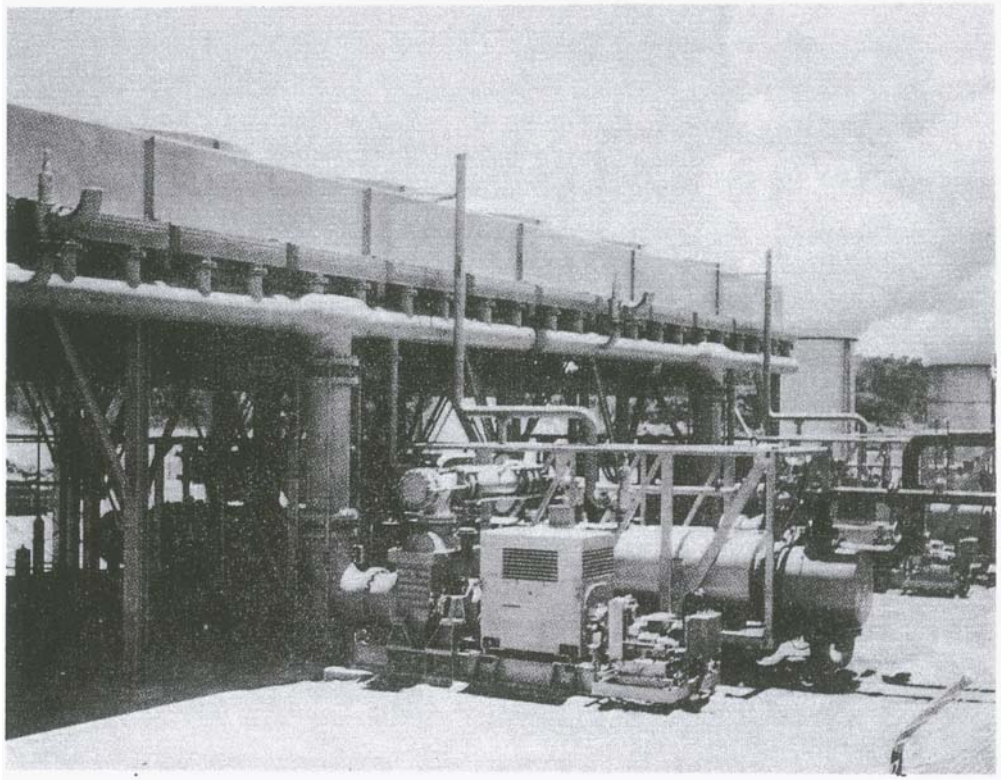
Figure 6 gives the monthly generated electricity of the TOI Power Plant.



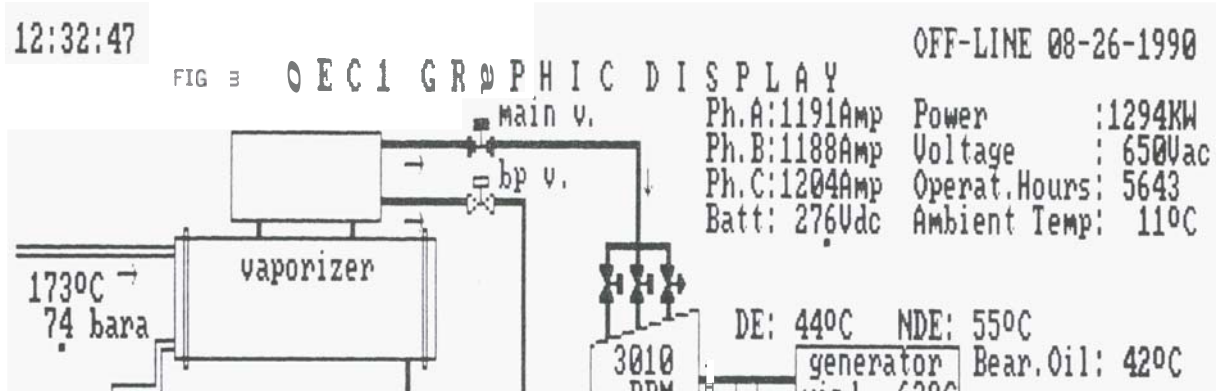
GEOTHERMAL AREAS IN THE ROTORUA-TAUPO GEOTHERMAL REGION

FIGURE 1

TARAWERA ORMAT Installation - TOI



Kawerau, Bay of Plenty, New Zealand



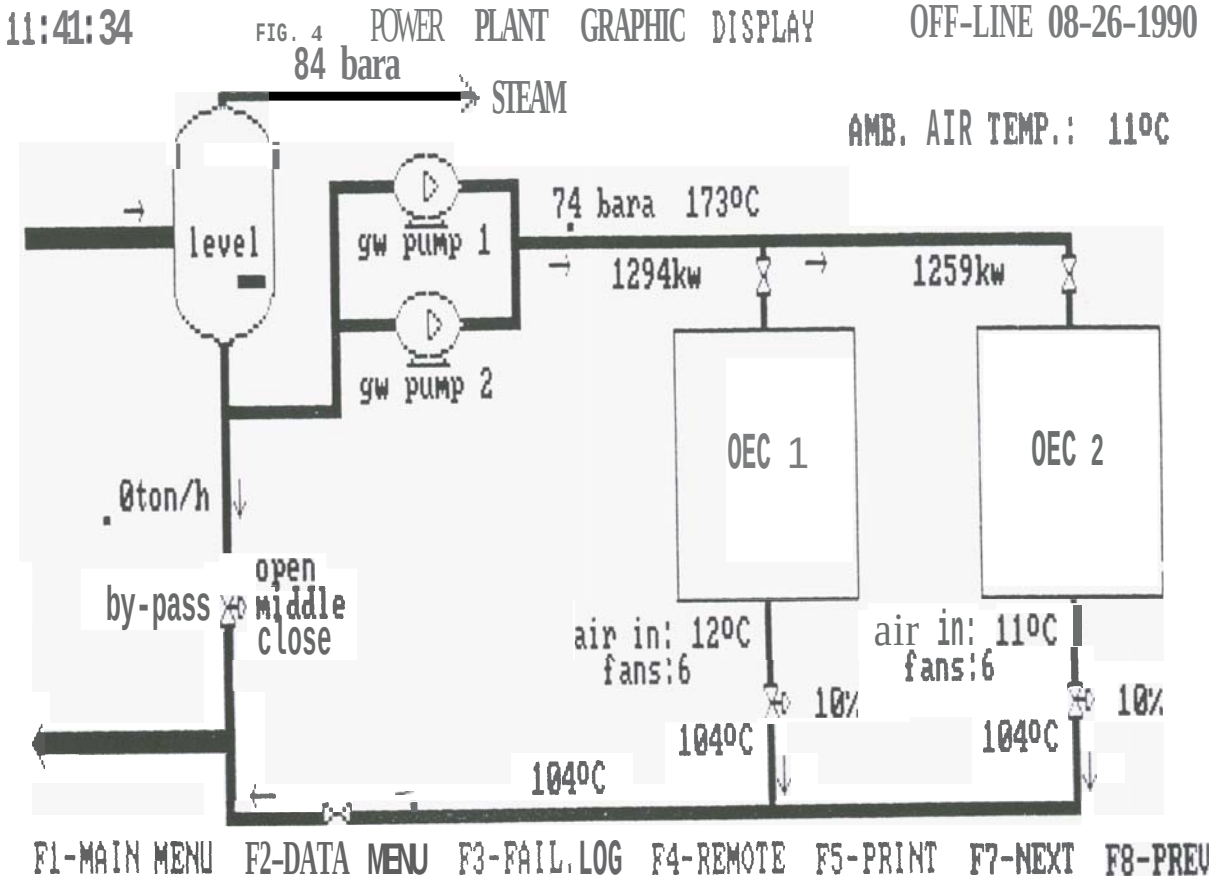
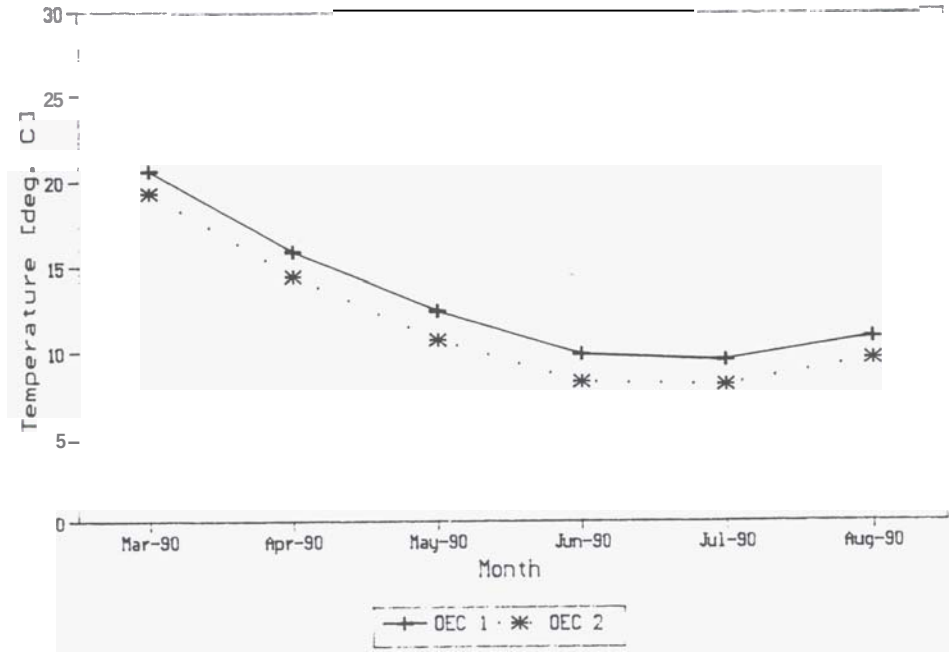


FIG. 5 BAY of PLENTY ELECTRICITY



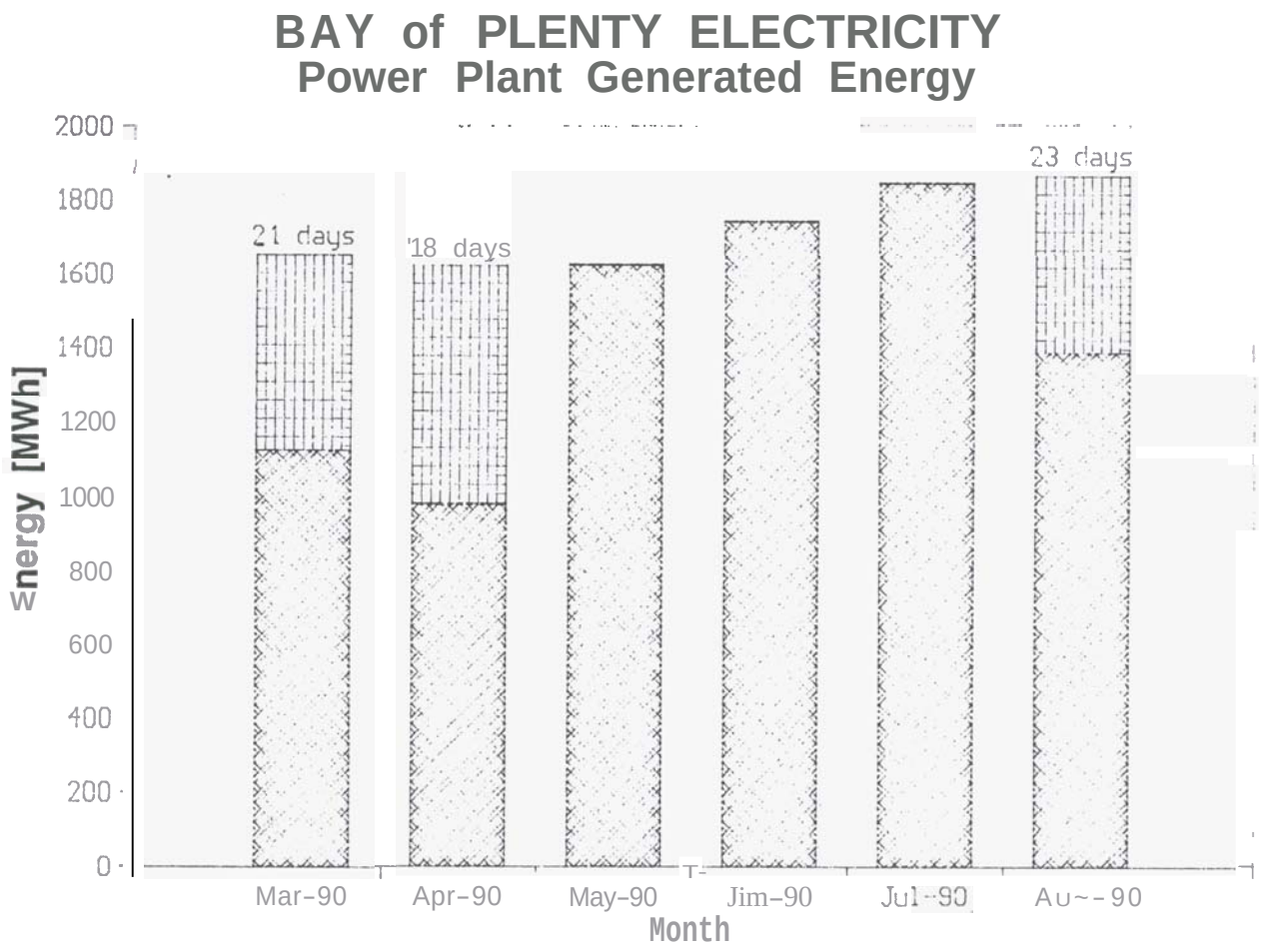


FIG. 7 BAY of PLENTY ELECTRICITY
Effects of the Remote Monitoring