

DUKE Energy  
Thermoelectric Center Egenor  
Piuria Plant – Peru



Fuel: Bunker

Machine/Type: Turbine

Test: Emissions Control, Efficiency, and  
Maintenance

---

**Xp Lab, Inc.**

946 Hawthorn St. San Diego, CA 92101  
Tel. (619) 233-3111 Fax: (619)233-3112  
[Xp3@xplab.com](mailto:Xp3@xplab.com) <http://www.xp3.com>

## OBJECTIVES

The objective of the test was to approve the change from diesel 2 to residual fuel treated with Xp3 and Xp3M, the latter as treatment to reduce the sulfur and vanadium effect in a turbo-generator. This process of changing the type of fuel used, involves risks due to the lower quality of the residual fuel, and the high content of sulfur and vanadium, chemicals that burn at a very high temperatures, resulting in high temperature corrosion.

For this test, according to the procedure 17 of the COES, the effective power of a thermoelectric unit, is the continuous power delivered by the unit, corresponding to Terminal generation (before ancillary services), when conditions of effective power is at full load.

## SCOPE

For this test we followed the following order of activities:

- I. Elaboration of the work plan: after our technical visit, which took into account the generator's work conditions and its fuel storage, the fuel supply plan was analyzed to determine the ideal point where Xp3 would be added.
- II. Execution of the test: with COES - SINAC auditing and the supervision of potency study by CENERGIA, following international standards and techniques. This assessment is more specific by means of calculation and determination of the effective power of the generating unit according to the scope specified in the PR-17 procedure of COES SINAC; determining the yield curve of the generating unit based on mathematical adjustments derived from measurements taken at the following nominal load conditions: empty, 25%, 50%, 75% and 100%.
- III. Visual comparison of characteristic of metal parts wear through photographic images, taking into account the technical characteristics of the fuel based on laboratory tests.

## TECHNICAL CHARACTERISTICS OF THE THERMAL UNIT

EGENOR is an electricity generation company, which forms an integral part of the national interconnected system. Currently there are two hydroelectric plants and six thermoelectric power plants. Piura gas turbine, subject of this study, is installed within the area that occupies the Central Termica of Piura.

The generator where the test was performed is a GE generator S634A type of 28750 KVA.

---

### **Xp Lab, Inc.**

946 Hawthorn St. San Diego, CA 92101  
Tel. (619) 233-3111 Fax: (619)233-3112  
[Xp3@xplab.com](mailto:Xp3@xplab.com) <http://www.xp3.com>

# CASE STUDY



## RESULTS

### Emissions:

It was proven that the change of the diesel fuel without additives to the residual # 6 with Xp3, generated minimum changes in emissions, and remained well below the recommended limits. The table that follows shows the results of two periods prior to the change from diesel to residual with Xp3, and those of later periods when Xp3 was already used with the residual fuel.

Parameters	26-Oct-04	26-Oct-04	9-Mar-05	17-Jun-05	26-Oct-05	Recomdation
Flue Gas temp (°C)	413	412	280	460	440	--
CO <sub>2</sub> (%)	6.8	6.7	1.9	0	1.8	> 0
CO (ppm)	10	27	25	15	16	< 100
NO <sub>x</sub> (mg/m <sup>3</sup> )	47.6	39	55.35	73.8	66.1	< 460 (*)
SO <sub>2</sub> (mg/m <sup>3</sup> )	0	0	179.6	128.3	125.3	< 2000(*)
Ambient Temp (°C)	32	31	36	40	38	--

(\*) Note: IFC/BM International Finance Coporation of the World Bank. General Environmental Guidelines (01-07-98).

### Effective Power:

unit	Power Test(*)	Power ISO	Power Effective	Power Auxiliary	Deviation %
gas turbine	20 203,0	23 57,1	20 950,7	68,0	1,15

(\*) tests on unit were conducted on March 9, 2005

Taking into account the level of uncertainty to the precision of the Registrar power (0.2), it was obtained as a definitive result for the effective power of the unit.

Effective power of the Piura gas turbine: 20 950,7 KW +/- 41,9 KW

### Efficiency:

Related Values to the Gas Turbine Efficiency Test							
Unit	Load		Consumption Schedule of Fuel Gal/h	Efficiency (kWh/gal)	Specific Consumption of Fuel gr/kWh	Specific Consumption Heat - HR kcal/kWh	Efficiency (%)
	%	kW					
Gas Turbine	0	0,00	800,17	0,00	--	--	0,00
	25	5 237,68	1 083,00	4,84	722,37	7 158,60	12,01
	50	10 475,37	1 365,84	7,67	455,51	4 541,06	19,05
	75	15 713,05	1 648,67	9,53	366,56	3 632,55	23,67
	100	20 950,73	1 931,51	10,85	322,08	3 191,79	26,94

Taking into account the level of uncertainty to the precision of the Registrar power (0.2), it was obtained as a definitive result for the efficiency of the unit: Efficiency of the Piura gas turbine: 10,85 KWh/gal +/- 0,043 KWh/gal

## Xp Lab, Inc.

946 Hawthorn St. San Diego, CA 92101  
 Tel. (619) 233-3111 Fax: (619)233-3112  
[Xp3@xplab.com](mailto:Xp3@xplab.com) <http://www.xp3.com>

# CASE STUDY



## Ocular Inspection:

The Visual inspection (photography) clearly shows that the formation of none burn material is minimum, almost imperceptible in ash quantity and coloration; condition that was key to conclude that residual fuel treated with Xp3 and Xp3 M should continue to be used.

Comparisons can be seen between the photographic images that were taken during previous conditions, and then the subsequent pictures taken after the use of Xp3 and Xp3M.

This result was verified during the cleaning period conducted by the company technical team, who generated a photographic record to compare with previous maintenance periods.



---

## **Xp Lab, Inc.**

946 Hawthorn St. San Diego, CA 92101  
Tel. (619) 233-3111 Fax: (619)233-3112  
[Xp3@xplab.com](mailto:Xp3@xplab.com) <http://www.xp3.com>

Imagen: TOBERA 15 Diciembre 2005



---

## **Xp Lab, Inc.**

946 Hawthorn St. San Diego, CA 92101  
Tel. (619) 233-3111 Fax: (619)233-3112  
[Xp3@xplab.com](mailto:Xp3@xplab.com) <http://www.xp3.com>

# CASE STUDY



Imagen: INTERIOR TURBINA 20 Octubre 2004

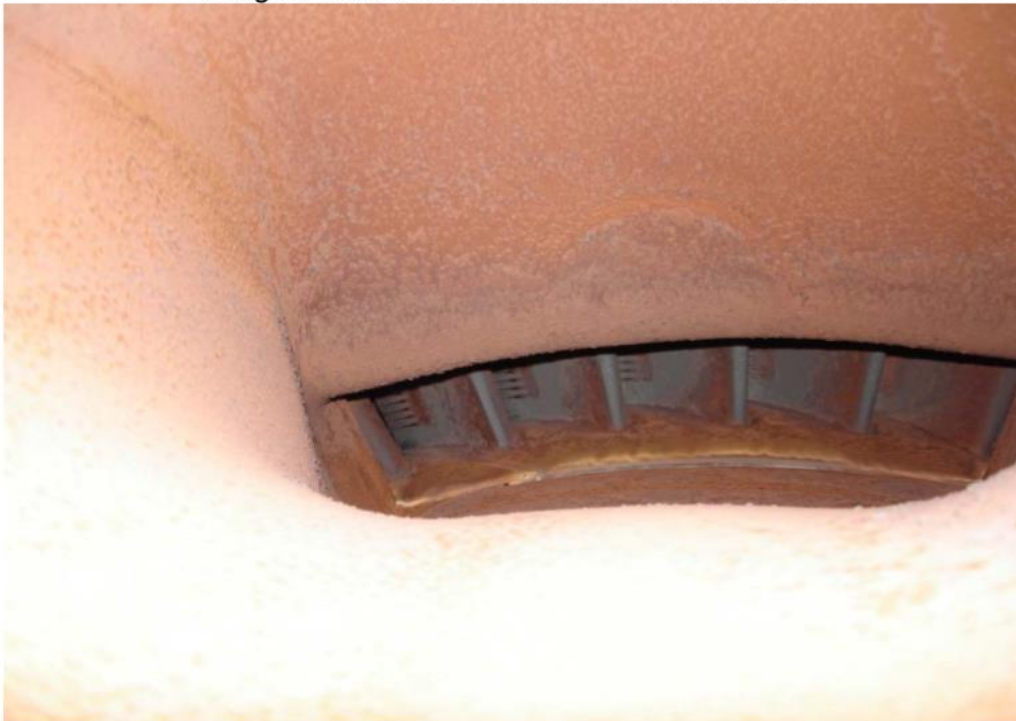


Imagen: INTERIOR TURBINA 15 Diciembre 2005



---

## **Xp Lab, Inc.**

946 Hawthorn St. San Diego, CA 92101  
Tel. (619) 233-3111 Fax: (619)233-3112  
[Xp3@xplab.com](mailto:Xp3@xplab.com) <http://www.xp3.com>