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tablas
graficas
diagramas

ENERGY AUDIT

FUNDICION MONCLOVA, S.A. DE C.V.

AUDITED BY: CORPORACION MEXICANA DE INVESTIGACION EN MATERIALES, S.A. DE C.V.

Saltillo, Coahuila

November 1996

CONTENTS

1.- OBJETIVE

1. GOAL

The purpose of this report is to present in an simple and orderly fashion the developments and conclusions obtained with the Second Level Energy Diagnostic (DEN-2) method applied the steel and granule building at Fundición Monclova, S.A. de C.V.

Also to present the current energy situation in this area. The highest demand and consumption items in quantity and percentage with which it is easier to define the energy importance of each user unit or system, and thus create an awareness of economic valuations on the importance to attack and correct the weak points detected.

2.- INTRODUCTION

.1 HISTORY

Fundición Monclova S.A de C.V. in a proudly Mexican company in the transformation industry, has over 40 years providing services to prestigious national and international companies and the community.

It started it's first operations in 1953 in the city of Frontera, Coahuila, on 128,100 m^2 . as access to the plant, it has a branch from Ferrocarriles Nacionales de Mexico (Mexico's National Railroad company) and Federal Highway 57 as road communication with the rest of the country.

FUMOSA is a company that makes smelted and forged products committed to satisfy their customer's requirements in foundry, metal-mechanic, petrochemical mining cement and automobile industries.

The most important for Fundición Monclova is their customers, catering to them with a service spirit, for which, the best asset they have is their human resources, foundation to meet and exceed their customer's expectancies.

FUMOSA looks for continuos improvement in every activity it performs to be the best option for his customers, this is our mission.

Currently, **FUMOSA** has induction and electric arc furnaces in metal smelting to produce granules, slabs, casted parts, and rolls, with a 5,00 ton combined capacity per month.

Among the products that **FUMOSA** offers, the following'

* Static or Centifugated Casting Rolls in iron or steel and forged steel rolls for lamination mills producing laminated steel, and cold or hot rolled forms, mills for pipes with or without seams, mills for plating non-ferrous metals and mills processing plastic products or for the rubber transformation industry.

* Cast Steel Products such as : Big dimension gears, ladles for steel or similar processes, valves with a wide variety of capacities and pressure for fluid control in chemical industries.

* Forged Steel Bars : In carbon steel medium or high alloy.

* Steel granules made under specifications SFSA-20-66. Used in automotive and smelted parts cleaning processes.

* Gray iron smelted products: such as ingots, marbles, machine center tables etc.

Now days, **Fundición Monclova S.A. de C.V.** in a stage to obtain concrete results in every thing it has planed. It has been concerned with bringing high technology into the plant and promote the necessary training among it's employees with the purpose of developing multiple abilities in them for their personal and professional improvement.

With these kind of procurements and this focus for their human resources. **FUMOSA** is making the effort to stay in a highly competitive market, even after going through difficult times, it has gained international marketshare, mainly in the United States, being able to place a good quantity of rolls in this country.

This kind of product is the way to pull the company forward (since roll sales provide the highest return), not forgetting the importance of other products, each day striving to develop more productive processes such as steel, specifically Granule Department, with the vision of integrating steel granules into the international market.

2.2 PRODUCTION PROCESS DESCRIPTION.

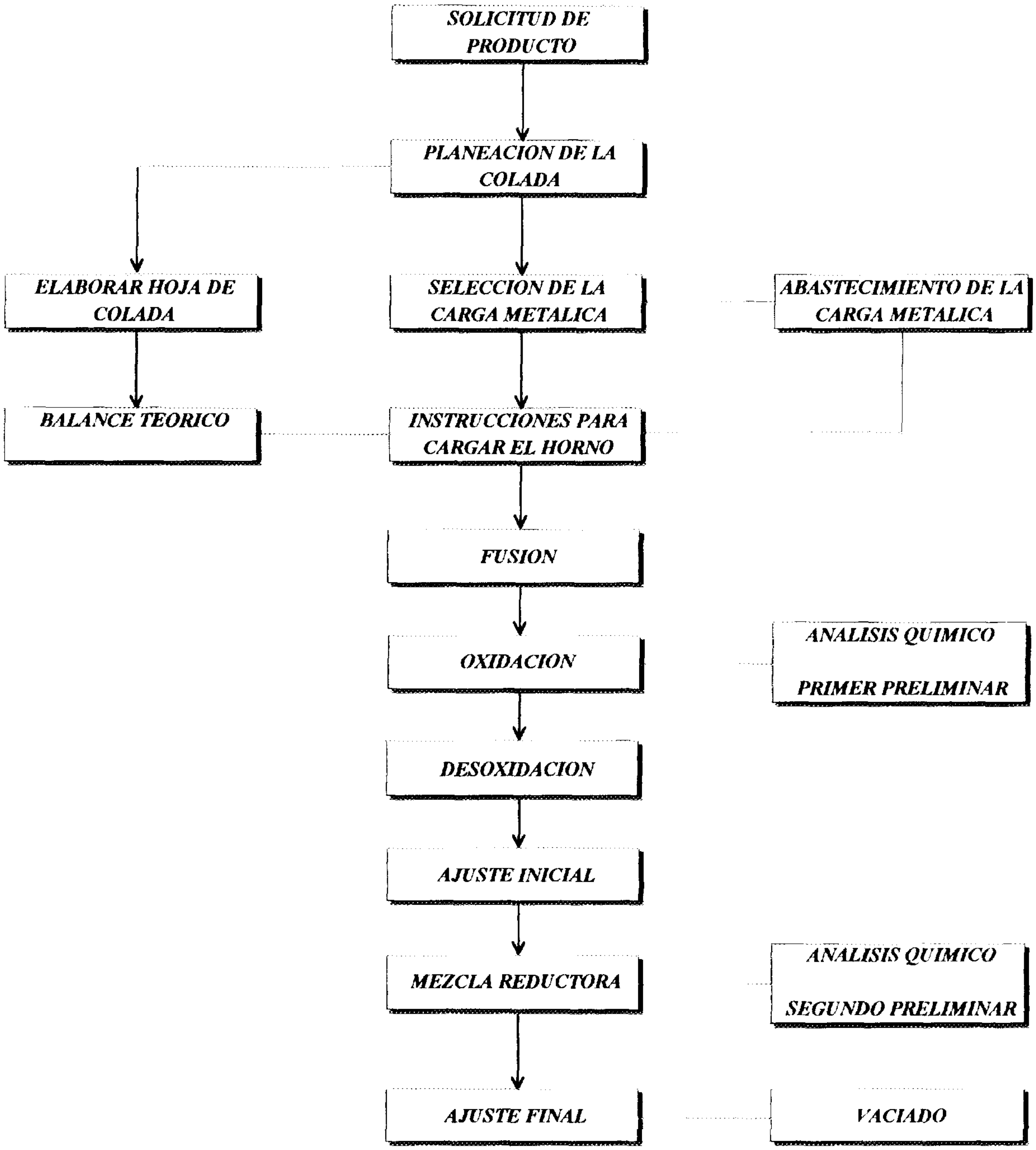
FUMOSA is a company of Monclova Industrial Group (GIM), dedicated to the smelting business. FUMOSA has two main production buildings: Smelting and Steel, in this last one two main products are produced: granules in different sizes and special iron alloys to fabricate laminating rolls.

The production process for any of the products made in the steel area, starts with an order from the sales and shipment department, later this order goes to the Steel Smelting department to be scheduled into the monthly production program. As the order is generated, this goes to the supervisor for placement and follow-up. The start of the smelting process initiates with the loading of raw material (scrap) from the stockyards to the container ladles, once they have the indicated load depending on the kilograms on the order, these are poured into the furnace; the kind of furnaces that FUMOSA has in the steel area are two arc type, 4.5 and 5 MV, furnaces by Withing. Once the load is in the furnace the smelting process begins, with a duration of 100 to 120 minutes for granules and 120 to 160 minutes for special steels per cast, depending directly on the kind of alloy the want to obtain.

In the case of granules, there is an atomization pit into which the liquid iron is poured at a temperature of 1730°C (aprox.), the process is based mainly on the direct contact of water pressure jets with the melted iron, generating, as a result of this thermal shock, small iron pellets (granules) and later processed for selection, hardening, cooling, etc. before being packaged and shipped.

For special steels the fusion process is the same as for granules, only that after the arc furnace, the melted iron goes to a process for degasification, and is finally casted into molds that have been previously heated in the casting area

The following diagram shows a schematic of the production process:



SOLICITUD DE PRODUCTO
PLANEACION DE LA COLADA
ELABORAR HOJA DE COLADA
SELECCION DE LA CARGA METALICA
ABASTECIMIENTO DE LA CARGA METALICA
BALANCE TEORICO
INSTRUCCIONES PARA CARGAR EL HORNO
FUSION
OXIDACION
ANALISIS QUIMICO PRIMER PRELIMINAR
DESOXIDACION
AJUSTE INICIAL
MEZCLA REDUCTORA
ANALISIS QUIMICO SEGUNDO PRELIMINAR
AJUSTE FINAL
VACIADO

3.- CURRENT ENERGY SITUATION IN THE ELECTRIC AREA

3.0 CURRENT ENERGY SITUATION OF THE ELECTRIC AREA

Next we present a series of information and statistical data , as well as the installed electric load that represents the current energy situation at Fundición Monclova S.A. de C.V.

3.1 ELECTRIC AREA ANALYSIS

Electric energy is supplied through two circuits or feed lines to the connection as FUMOSA by Comisión Federal de Electricidad at 13.8 kV with a controlled HM tariff, corresponding to 51DD18E090020004 and from here it is distributed to all plant areas

Next we present the subjects into which we divided the analysis for the current energy situation of the plant

3.1.1 ENERGY CONSUMPTION

Here we present the tables and charts with history data for electric energy consumption provided by maintenance personnel at FUMOSA from January to September of 1996.

3.1.2 TOTAL INSTALLED LOAD

Here we present the total installed load at Steel and Granule Area represented by nominal loads at different electric substations independently if they are extra equipment or in operation (kVA converted to kW, 1 kVA = 1 kW with F.P. = 1).

Also shown are the pie charts for this concept.

3.1.3 ENERGY COSTS .

Here we present a list of costs by demand kW, kWh and fuel adjustment factor, which are parameters that compose Basic Monthly Invoicing (F.M.B.) for electric energy. With the pie chart and table we represent each of these concepts by month .

Cost of electric energy used for calculations were those for the month of August , 1996, according to the Official Gazette of the Federation, for the northeast zone they are in HM tariff:

Charge for kilowatt of invoicable demand =	$ 30.401
Charge for kilowatt-hour of basic energy =	$ 0.1584
Charge for kilowatt-hour of peak energy =	$ 0.25334
Charge for fuel adj. factor =	$ 0.09409

(See annex for more details about tariff)

3.1.4 EQUIPMENT AND SYSTEM ANALYSIS

This chapter analyses the operation conditions for the main equipment and systems used for production, such as transformers, electric motors, illumination, air compressors getting demand profiles energy consumption efficiency and presenting nominal and plate data for each equipment.

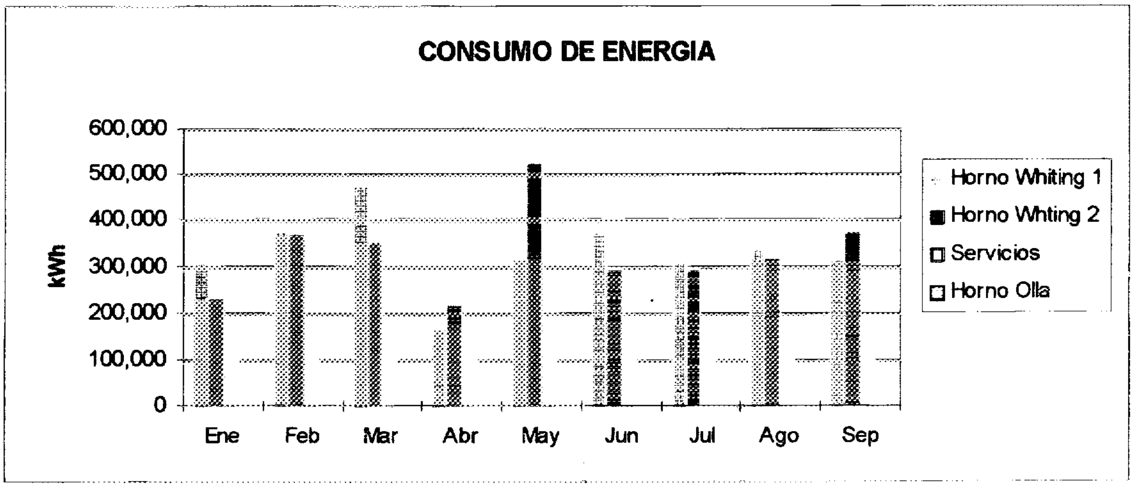
3.1.1 ENERGY CONSUMPTION

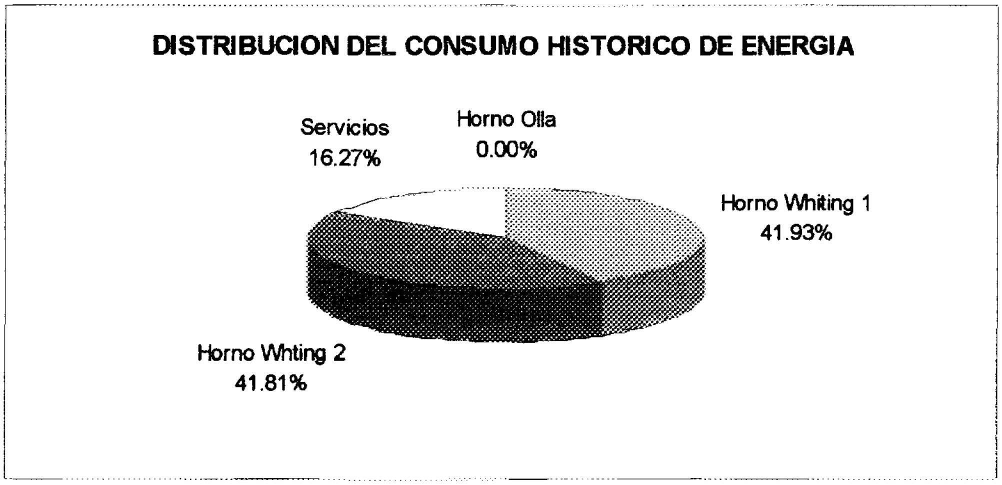
At Fundicion Monclova S.A. de C.V. only in the Steel And Granules division, we have four electric substations that provide electric energy to three arc furnaces and several service equipment such as drying and tampering furnaces, cooling towers, mills, cranes, illumination, etc.

Electric energy consumption among the substations is varies widely due to production and operations needs of each, the next table and chart shows historic data from January to September 1996according to measurement equipment installed.

The refinery arc furnace presents a null consumption since it has not been used in this period, only goes into operation when the melt from the two other furnaces are mixed and it is necessary to maintain a temperature at the moment of de-gassing.

Period	Consumo de energía (kWh)				
	Horno Whiting 1	Horno Whiting 2	Servicios	Horno de Olla	Total
Ene '96	311,564	231,335	117,760	0	660,659
Feb '96	377,941	369,632	124,160	0	871,733
Mar '96	478,206	352,718	133,120	0	964,044
Abr '96	168,137	221,530	106,240	0	495,907
May '96	319,234	527,953	124,160	0	971,347
Jun '96	376,425	292,975	119,040	0	788,440
Jul '96	309,892	292,504	138,240	0	740,636
Ago '96	334,826	320,134	145,920	0	800,880
Sep '96	316,245	374,923	152,320	0	843,488
Total	**2,992,470**	**2,983,704**	**1,160,960**	**0**	**7,137,134**





The charts show us the total energy consumption for each of the electric substations, meaning the consumption within base and peak hours and seeing the difference between them which will be reduced with a more controlled operation of the various equipment.

With the implementation of energy saving measures proposed, will have as a consequence a better use of energy and a significant savings in Monthly Basic Invoicing (F.M.B.)

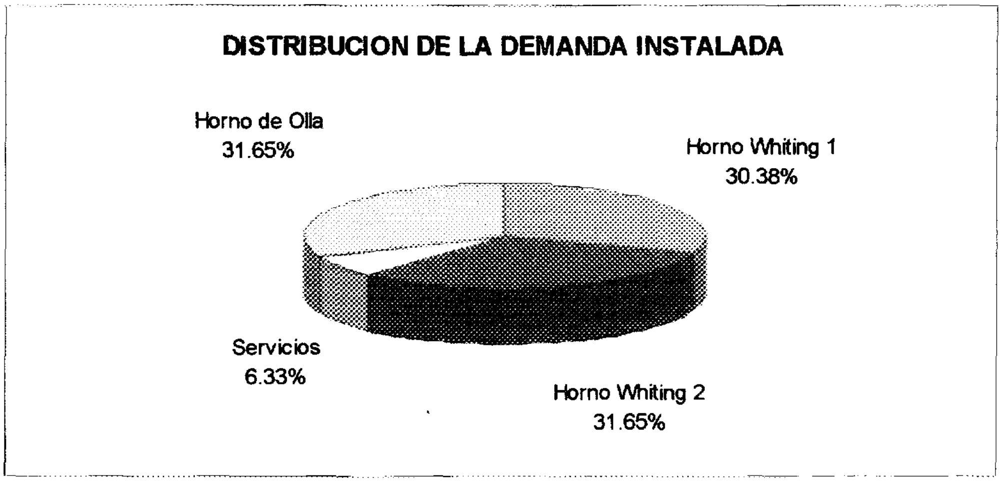
3.1.2 INSTALLED LOAD

The average installed electric load in Steel and Granule areas according to information provided by FUMOSA is aprox. 15,480 kW and is distributed in the following way:

Substation	Total kW	%
Arc Furnace Whiting no. 1.	4,480	30.38
Arc Furnace Whiting no. 2.	5,000	31.65
Arc Furnace for Ladle refinery.	5,000	31.65
Services.	1,000	6.33
Total	**15,480**	**100**

To better visualize the total installed load by sector, the following pie chart compares each sector.

INSTALLED DEMAND DISTRIBUTION



.1.3 ENERGY COSTS

Next we show energy costs for Demand kW, kWh and adjustment factor for fuel, which are parameters that make up the Monthly Basic Invoicing (F.M.B.) for electric power.

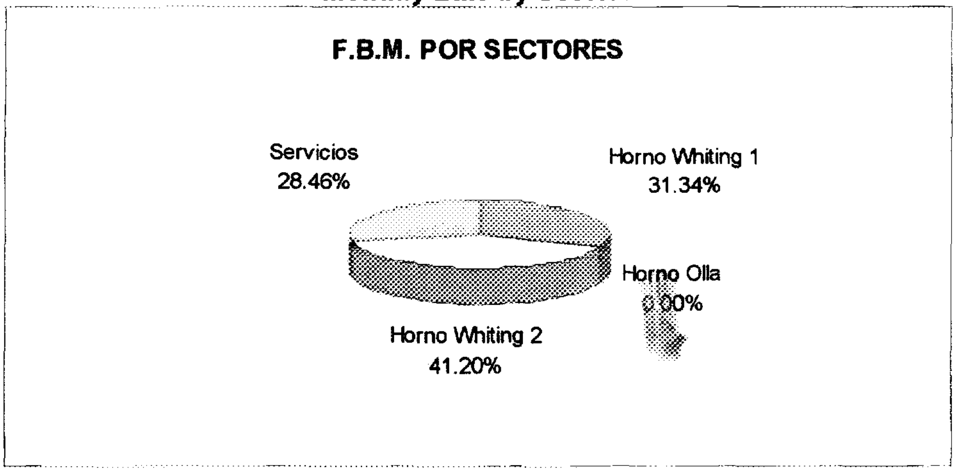
The cost of electric energy for August 1996 according to the Official federal gazette for the north east zone are :

Charge for kilowatt of invoiced demand =	$	30.401
Kilowatt-hour charge for base energy =	$	0.1584
Kilowatt-hour charge for peak energy =	$	0.25334
Charge for Fuel Adjustment Factor =	$	0.09409

On the next table we can see the invoiced kW demand, base kW, peak kWh that form the basic monthly bill plus the fuel adjustment factor, also included is the estimated monthly amount. Electric parameters presented were obtained from monitoring and data provided by plant personnel at the electric substations.

Substation	kW			Month Consumption(kWh)			kVArh	Factor de Potencia	F.B.M.
	Base	Peak	Fact.	Base	Punta	Total			
Furnace Whiting 1	2,431	0	486	279,798	0	279,798	196,320	81.86%	$85,427
Furnace Olla	0	0	0	0	0	0	0	100.00%	$0
Furnace Whiting 2	3,200	0	640	356,937	0	356,937	346,473	71.75%	$109,580
Services	496	408	426	199,469	41,112	240,581	183,733	79.47%	$77,590
Total	**6,127**	**408**	**1,552**	**836,204**	**41,112**	**877,316**	**726,526**	**77.02%**	**$272,597**

Monthly Bills by Sectors



demand kW .- Is the calculated active power using the next formula:

DF = DMP + 1/5 (DMB - DMP)

where :

DF = Billable Demand
DMP = Maximum Demand for Peak Period
DMB = Maximum Demand for Base Period

but if (DMB - DMP) < 0, then :

DF = DMP

base kWh per month .- Is the energy consumption within base time in the month

peak kWh per month .- Is the energy consumption within peak time of the month (18:00-22:00hrs - Monday to Saturday).

For the aprox. calculation of the last two points, we consider month with 31 days, out off which 4 days are Sundays.

base kWh per month = demand* kW base hrs. used per month (aprox)

peak kWh per month = demand* kW peak hrs. used per month (aprox)

In the plant, the process is continuos, so that most of the equipment run at the same time and according to what could be observed in monitoring general supply parameters, the approximate time is as follows:

aprox. working daily base hours Monday to Saturday =	20 hrs.
aprox. working daily peak hours Monday to Saturday =	4 hrs.
aprox. work daily hours for Sundays =	0 hrs.

base hours in the month = (20 hrs. * 27 Days) = **540 hrs.**
peak hours in the month = (4 hrs. * 27 Days) = **108 hrs.**

Basic monthly billing (F.B.M.).- Is the approximate amount that would correspond to each equipment from the Total Basic Monthly Billing

So :

HM tariff

F.B.M. = (kW dem. * $/kW dem fac.) + (kWhp * $/kWhp) + (kWhb * $/kWhb) + {(kWhb + kWhp) * Fuel adjustment factor}

3.1.4 EQUIPMENT AND SYSTEM ANALYSIS

In this point, we will analyze the main equipment and systems in Steel and Granule area at Fundición Monclova S.A. de C.V.

The electric parameter monitoring was performed using OPH-03 electric analyzers, connected through power and current transformers to have the necessary signals to obtain the different electric parameters calculated by the analyzer.

Charts presented for each measurement and shown in the corresponding annexes, are :

1.- Chart for kW Vs time.
2.- Chart for Voltage Vs time.
3.- Chart for Current Vs time.

1.- Chart for kW Vs time. In this chart we can see the behavior of electric demand in the equipment that had a network analyzer installed during the monitoring process.

2.- Chart for Voltage Vs time. As will be seen further on, the behavior of the three phase voltage could be considered uniform, except with the variations of significant loads, that affect directly the unbalance of the phases.

3.- Chart fro Current Vs time . The current's behavior is similar to voltage, since it changes significantly with load, directly affects voltage to compensate active equipment power. The current variations by load are shown in the corresponding chart for each equipment.

The increase of electric loads is shown in the charts and has data from different loads that form the electric network of the plant, the data is :

Plate data .- Are the data provided by the equipment manufacturer.

Measured data.- These data where measured through a digital multimeter that provides us with Power factor, voltage, and Current (1pc.) necessary to calculate equipment real demand energy

Demand kW.- Is the power calculated with the above data

demand kW = 1.732 x Volts x I.p.c. x F.p.

base kWh per month .- Is the energy consumption within base time for the month

peak kWh per month .- Is the energy consumption within peak time for the month (18:00-22:00 hrs. de Monday to Saturday)

For the aprox. calculation of the last two points, we consider month with 31 days, out off which 4 days are Sundays.

base kWh per month = demand* kW base hrs. used per month (aprox)

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The cost of electric energy for August 1996 according to the Official federal gazette for the north east zone are :

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So :

HM tariff

F.B.M. = (kW dem. * $/kW dem fac.) + (kWhp * $/kWhp) + (kWhb * $/kWhb) + {(kWhb + kWhp) * Fuel adjustment factor}

3.1.4.1 TRANSFORMERS.

The transformer is an equipment that converts , in general, an input power (primary) and a different output (secondary), based on the laws of magnetic induction.

The unloaded voltages on the primary and secondary sides of the transformer are proportional to th number of windings with a great approximation. Since the magnetizing current circulates only on the primary side and is also very small, produces a voltage drop in its internal resistance.

On load, however, significant voltage drops are produced, especially in the internal impedance of the windings.

Power losses are produced through a transformer (P_p), so that at the outlet we have a P_2 smaller than P_1.

N performance will be:

N = outlet power / inlet power = P_2 / P_1

$$N = \frac{P_2}{P_2 + P_p}$$

It is important to take notice that the transformers present much higher performance than motor and generator efficiencies. Next we present typical performance values.

Table 1. Typical Transformer performance .

Transformer Type	*Nominal Power*	*Performance(%)*
de Distribution	10 kVA - 1,000 kVA	96.0 a 99.0
de Power	10,000 kVA - 100,000 kVA	99.0 a 99.7

Electric concepts .

- **Inlet Nominal Voltage.** Is the one established at the inlet (primary) of the transformer during nominal service and for which it has been designed
- **Output nominal Voltage.** Is the one that appears at the outlet (secondary) of the transformer when it is empty, or without a load, applying nominal voltage and frequency to the primary side of the transformer
- **Transforming ratio.** Is the quotient between inlet and outlet nominal voltages; i.e. 20,000 / 40,000
- **Nominal power .** Is the conventional value of the apparent power, given in kVA or MNA that is used as a base for transformer construction. It determines a defined value of the admissible nominal intensity when nominal voltage is applied. Is the apparent power that is capable of withstanding the transformer in continuous use without exceeding permissible heat limits for insulation. Expressed in kVA it is :

$$Sn = 1.732 \times Vn \times In$$

Being " Sn " the nominal power, " Vn " nominal voltage in kV and " In " intencity in ammpers.

A transformer does not work continuosly in nominal level, with nominal intensities In_1 in the primary and In_2 in the secondary, but they can be taken to other intensities I_1 and I_2.

It is very important to know the load index " C " of a transformer, since the losses depend on it and it gives a measure of what is demanded from the transformer. In this way the load index is defined as the quotient between the intencity of the work and nominal intencity

$$C = \frac{I_1}{In_1} = \frac{I_2}{In_2}$$

If $C \leq 1$, the transformer is working freely, since this means that through it flow currents lower that those it has been designed for, its heats will not be dangerous and can work continuously.

If on the contrary, $C > 1$, the transformer is overloaded, since through its windings flow higher than nominal currents. The heating reached could be dangerous and damage the insulation.

Function at over loaded conditions cannot be continuos. For each load index $C > 1$ the transformer can only work a certain time.

- **Medium load index.** The constant load requirements are not the most frequent. The load index tends to change through time (day, month, year, etc.) depending on a certain cycle. To find the medium load index, we calculate a medium intencity that produces the same losses that those intensities that really circulate.

Medium intensity is:

$$Ic = \sqrt{\frac{\left[\left(I_1^2 \times t_1\right) + \left(I_2^2 \times t_2\right) + \left(I_3^2 \times t_3\right) + \left(I_n^2 \times t_n\right)\right]}{\left(t_1 + t_2 + t_3 + t_n\right)}}$$

and the medium index load Cm is:

$$Cm = \frac{Ic}{In}$$

Transformer loss analysis.

Power loss that are produced in a transformer are basically two kinds:

- **Loss in the magnetic circuit (P_o).** Called also loss in iron or vacuum losses, since they are found through an empty transformer test. They are independent of the load that the transformer is being subjected to and practically invariable to constant voltage and frequency. It is a data that normally the manufacturer supplies.

- **Losses through Joule effect in the windings (P_{cu}).** Are due to the losses in the transformer's windings due to existing resistance in these (Joules effect) Are usually called copper losses since windings are usually made of copper even thou soon are made of aluminum.

Varies proportionally with the square of the intencity. If we know the losses produced by this concept in nominal regime (P_{cc}), when the transformer works with a load index C, the copper losses will be:

$$P_{cu} = C^2 \times P_{cc}$$

Copper losses in a transformer at nominal (P_{cc}), is a data that the manufacturer provides

Total losses in a transformer (P_p), that works with an index load C, will be:

$$P_p = P_o + P_{cu} = P_o + C^2 \times P_{cc}$$

As can be seen, the total losses in a transformer are not cônstant, but depend n the load index. When this increases, losses increase.

Table 2. Typical loss values for a transformer.

NOMINAL POWER kVA	LOSS	
	Iron (Po) Watts	Copper (Pcu) Watts
50	345	810
75	400	1,080
125	480	2,350
160	490	2,600
200	570	3,400
250	675	4,230
315	750	5,250
400	900	6,200
500	1,000	8,050
630	1,250	9,000
800	1,690	10,000
1,000	1,800	12,600
1,250	2,010	16,800
1,600	2,500	19,000
2,000	2,750	23,900
2,500	3,480	29,600
3,150	3,500	30,500
4,000	4,300	34,000
5,000	5,000	39,500
6,300	6,300	45,000
8,000	7,000	57,000
10,000	7,600	68,500

Transformer performance. Optimal load Index.

Power given by the secondary is :

$$P_2 = \sqrt{3} \cdot V_2 \cdot I_2 \cdot Cos(\Phi_2)$$

where : " V_2 " is the voltage in secondary bronzes with an intencity of " $I_2 = C \times In_2$ " and a power factor " $Cos(\Phi_2)$ ".

Performance for Transformer " N ", will be :

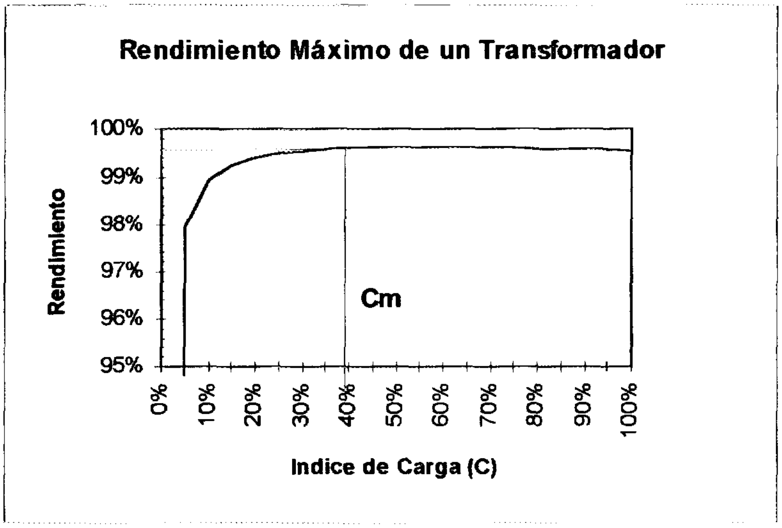
$$N = \frac{\sqrt{3} \cdot V_2 \cdot C \cdot In_2 \cdot Cos(\Phi_2)}{\left(\sqrt{3} \cdot V_2 \cdot C \cdot In_2 \cdot Cos(\Phi_2)\right) + \left(P_o + C^2 \cdot P_{cc}\right)}$$

where : $P_o + C^2 \cdot P_{cc}$ = transformer losses for a C load index

In this performance expression we can see:

- If the load index "C" is constant, performance will increase when the power factor increases "Cos (Φ_2)" of the load connected to the secondary. So energy will be saved if the power factor for the load connected to the secondary.

For the fixed power factor, $Cos(\Phi_2)$ = constant, the performance varies with the load index " C ", as indicated in the next figure. As can be seen there is a load index $C = C_M$, for which a maximum performance is produced $N = N_{Max}$.



It is easily proven that the transformer has a maximum performance when :

$$P_o = C^2 \cdot P_{cc}$$

or, when copper losses equal iron losses, so :

$$C_M = \sqrt{\frac{P_o}{P_{cc}}}$$

For efficiency calculation for each one we used the medium load index and the medium power for the whole monitoring period, we obtained currents and powers every 5 minutes in the measurements made with the electric network analyzer OPH-03 and calculating the Ic (medium current) and output power in the following manner:

$$Ic = \sqrt{(I_1^2 * t_1) + (I_2^2 * t_2) + (I_3^2 * t_3) + (I_n^2 * t_n) / (t_1 + t_2 + t_3 + t_n)}$$

As $t_1 = t_2 = t_n = 5$ minutes

$$Ic = \sqrt{(I_1^2 + I_2^2 + I_n^2) * t/n * t}$$

$$\mathbf{Ic} = \sqrt{(I_1^2 + I_2^2 + I_n^2) / n}$$

Conclusions

According to the calculations made with the data obtained from transformer monitoring and presented in the following table, we conclude that they are in adequate performance, with in the standard values for each nominal capacity, but we have to take into account cOomponent deterioration due to operation time and manufacturing tear, so the efficiency of the transformers is a litter shrieked and is not directly related to the previous performance chart.

EFICIENCY OF TRANSFORMERS

Transformers in sub-stations	kVA	Transformers Relation	V sec.	Inom	Ic	Power Output (kW medio)	Cm	Po (kW)	Pcc (kW)	Pot. Ent. (kW)	Eficiency (%)
Horno Whiting no. 1	4,480	13.8 / 0.260 kV	260	9,948.48	5,837.70	1,015.53	58.68%	4.64	36.64	1,032.79	98.33
Horno Whiting no. 2	5,000	13.8 / 0.240 kV	240	12,028.48	8,912.50	1,170.25	74.09%	5.00	39.50	1,196.94	97.77
Horno de Olla	5,000	13.2 / 0.275 kV	275	10,497.59	0.00	0.00	0.00%	5.00	39.50	0.00	0.00
Servicios	1,000	13.8 / 0.460 kV	460	1,255.15	696.30	322.88	55.48%	1.80	12.60	328.56	98.27

3.1.4.2 ELECTRIC MOTORS

Due to the need to save energy and the great importance that motors have, we are making great efforts to optimize their use and application in productive sectors. According to information from the Federal Electric Commission, it is estimated that in our country motors consume around 60% to 70% of all electric power generated, so these are a good opportunity for energy savings.

Among the possibilities in energy saving in these equipment we have considered the following aspects.

A) Improvement in motor efficiency.
B) Optimize motor that work at a lower power than nominal.
C) Improve efficiency in motor-machine team in variable load conditions.
D) Improve operating conditions for electric systems and the quality of the power supplies to the motors.
E) Improve motor maintenance and repair technics

A) Improve motor efficiency

Here, the effort by the manufacturers has been oriented in searching for ways to reduce losses and to get high efficiency motors, through design improvement and use of materials with superior properties

Some of the technics used are :

1.- Use more copper in stator windings to reduce copper losses.

2.- Increase length of stator and rotor cores to reduce magnetic flow density in the iron, magnetic saturation and iron losses.

3.- Use more steel in stator to enhance cooling by conduction and reduce ventilation losses

4.- Use improved steels to reduce histerisis losses.

5.- Use thinner laminations to reduce parasitic currents.

6.- Improve machining of rotors to perfect between irons and reduce additional losses.

Even thou the process of high efficiency motors is 40 to 60 % higher that most conventional motors, the benefits offered can justify their cost if they are analyzed in an economic comparative analysis for each use in particular.

B) Motor efficiency that operate at a traction of their nominal power.

In many cases these operating conditions appear because they can be inherent to motor application, bur, there are motor with great capacity and continuous operation that are working under these conditions, because they have been selected with wide safety margins, or have been adapted to different applications to those originally intended in order to use existing equipment. These cases are very expensive to the company from an operation cost point of view.

C) Motor -Machine Efficiency with variable load

The processes using fluids such as liquids or gas and led with pumps, compressors and ventilators actuated with electric motors offer a great opportunity to start saving energy, since frequently the load variation is a requirement set by the processes themselves. Ii is this general practice, to regulate the process flow with valves and gates when these systems require lower flows that their total capacity, the devices reduce flow wasting part of the flow energy that comes from the motor-machine team.

Currently these processes work with a higher efficiency, if speed regulators are used to adequate the flow energy to the needs off the process even with load variation. These devices allow flow control through motor speed variation regulating the electric supply frequency to the motor. Frequency variation can be applied to AC motors from ¼ to 1,500 hp. that require precision control and high operation efficiency.

D) Electric supply quality.

Even is motors can accept variations up to 10% over or under nominal power without serious risk, from an efficiency point of view these variations are totally inconvenient.

The over power causes a decrease in power factor and increases losses in the stator even at empty conditions.

Another factor is phase unbalance, which brings a disproportionate increase in losses and drastic reduction in efficiency .

For these reasons, you should supervise your service network operation to detect abnormal conditions (low or high voltages and frequency, unbalance in phases) that can be through design, capacity or way of operation of the network or devices used, to be in a position to apply corrective measures.

In the tables, on the following pages operating conditions are shown for motors used in each of the areas of the plant.

CONCLUSIONS

Taking into account that motor application is practically in equipment that is very deteriorated, the performance of these motors is greatly reduced and directly reflects in operation costs.

SITUACION ELECTRICA DE LOS MOTORES PRINCIPALES
FUMOSA, AREA DE ACERACION-GRANALLA

Localización/Equipo	Datos de Placa					Datos Medidos			kW	Horas por dia		Consumo por mes (kWh)			F.B.M.
	HP	V	I	F.S.	RPM	V	I	FP	Dem	Base	Punta	Base	Punta	Total	
Torre de enfriamiento Aceración															
Bomba 1	20	440	26.0	1.0	1725	436	21.9	0.85	14.06	20	4	7,590.86	1,518.17	9,109.04	$2,871.58
Bomba 2	20	440	26.0	1.0	1725	433	21.4	0.86	13.80	20	4	7,453.18	1,490.64	8,943.82	$2,819.50
Bomba 3	25	440	32.0	1.0	1755	Fuera de servicio			0.00	0	0	0.00	0.00	0.00	$0.00
Bomba 4	40	440	55.0	-----	3500	440	31.4	0.90	21.54	20	4	11,629.65	2,325.93	13,955.57	$4,399.43
Bomba 5	40	440	50.0	1.15	1725	433	35.1	0.77	20.27	20	4	10,945.29	2,189.06	13,134.35	$4,140.54
Ventilador oriente	Inaccesible					435	10.1	0.66	5.02	20	4	2,712.04	542.41	3,254.45	$1,025.95
Ventilador poniente	Inaccesible					438	12.1	0.53	4.87	20	4	2,627.10	525.42	3,152.52	$993.82
Recuperador de arena															
Medición global del equipo	Inaccesible					442	64.9	0.60	29.81	20	4	16,097.55	3,219.51	19,317.06	$6,089.61
Colector de polvos lado norte															
Medición global del equipo	Inaccesible					457	77.0	0.75	45.71	16	0	19,746.94	0.00	19,746.94	$6,375.55
Tanque de rebombeo, horno W 1															
Bomba 1	7.5	440	10.8	-----	1800	430	6.7	0.69	3.44	9	2	836.66	185.92	1,022.58	$380.53
Bomba 2	7.5	440	10.8	-----	1800	430	10.2	0.87	6.61	9	2	1,605.99	356.89	1,962.87	$730.44
Torre de enfriamiento Granalla															
Bomba 1	50	440	63.4	1.0	1800	450	47.8	0.89	33.16	20	4	17,904.91	3,580.98	21,485.89	$6,773.32
Bomba 2	50	440	63.4	1.0	1800	455	45.4	0.89	31.84	20	4	17,194.87	3,438.97	20,633.84	$6,504.72
Bomba 3	50	440	64.0	1.0	1500	453	39.1	0.80	24.54	20	4	13,252.77	2,650.55	15,903.32	$5,013.44
Ventilador	Inaccesible					450	9.3	0.68	4.93	20	4	2,661.62	532.32	3,193.94	$1,006.88
T o t a l									259.60			132,259.43	22,556.78	154,816.21	$49,125.31

3.1.4.3 ILLUMINATION

The way to calculate FMB in illumination area is very similar to electric motors, only demand calculation is different. which is done :

Demand kW = (No. of cabinets * No. lamps per cabinet * Watts per lamp* 1.2)/1000

Note: *Factor 1.2 is to consider 20% of lamp as ballast power, for fluorescent lamps, and high discharge lamps.*

base kWh per month = demand* kW base hrs. used per month (aprox)

peak kWh per month = demand* kW peak hrs. used per month (aprox)

Basic monthly billing (F.B.M.).- Is the approximate amount that would correspond to each equipment from the Total Basic Monthly Billing

So :

HM tariff

F.B.M. = (kW dem. * $/kW dem inv.) + (kWhp * $/kWhp) + (kWhb * $/kWhb) + {(kWhb + kWhp) * Fuel adjustment factor}

tariff HM

F.B.M. = (kW dem. * $/kW dem fac.) + (kWhp * $/kWhp) + (kWhb * $/kWhb) + {(kWhb + kWhp) * Factor de Adjust poor Combustible}.

Next we have the illumination plan, specifying if they are fluorescent, high discharge or incandescent. Within high discharge illumination we have high pressure sodium vapor lamps (V.A.S.P.) Mercury vapor (V.M.) and Metallic additives (A.M.). Also fluorescent lamps found were 2*75 and 2 *39 Watts respectively

CONCLUSIONS

Illumination in general is very deteriorated due to lack of maintenance, also the buildings mix high discharge metallic additive type, mercury vapor, and high pressure sodium, with the consequent mixture emission temperature color that is not adequate for the process

ILUMINACION
FUMOSA, AREA ACERACION-GRANALLA

No.	Localización	Bulbo ó lámpara por candil			Horas por día		Consumo por mes (kwh)			kW	F.B.M.	Observaciones
		No.	Tipo	Watts	Base	Punta	Base	Punta	Total	Reales		
	Nave de Aceración											
5	Nave	1	A.M.	400	20	4	1,037	207	1,244	1.92	$392	1 no funciona
11	Nave	1	V.M.	400	20	4	1,555	311	1,866	2.88	$588	5 no funcionan
14	Nave	1	V.S.A.P.	400	20	4	3,629	726	4,355	6.72	$1,373	
2	Cuarto de control horno W 2	2	Fl	75	20	4	194	39	233	0.36	$74	
4	Cuarto subestación gruas	2	Fl	75	20	4	292	58	350	0.54	$110	1 no funciona
9	Cuarto de motores desgasificado	2	Fl	75	20	4	486	97	583	0.90	$184	4 no funcionan
1	Cuarto de motores desgasificado	1	A.M.	400	20	4	259	52	311	0.48	$98	
1	Cabina de control horno de olla	2	Fl	75	20	4	97	19	117	0.18	$37	
2	Cuarto de control horno W 1	2	Fl	75	20	4	194	39	233	0.36	$74	
4	Cuarto subestación horno W 1	2	Fl	75	20	4	97	19	117	0.18	$37	3 no funcionan
8	Gruas	1	Inc.	200	20	4	648	130	778	1.20	$245	2 no funcionan
2	Gruas	2	Fl	75	20	4	194	39	233	0.36	$74	
	Nave de Granalla											
5	Nave	1	V.S.A.P.	75	20	4	243	49	292	0.45	$92	
8	Nave	1	A.M.	75	20	4	243	49	292	0.45	$92	3 no funcionan
5	Nave	1	V.M.	75	20	4	146	29	175	0.27	$55	2 no funcionan
1	Nave	2	Fl	75	20	4	97	19	117	0.18	$37	
2	Cuarto de control	2	Fl	75	20	4	194	39	233	0.36	$74	
1	Oficina	2	Fl	75	20	4	97	19	117	0.18	$37	
1	Sanitario	2	Fl	75	20	4	97	19	117	0.18	$37	

ILUMINACION
FUMOSA, AREA ACERACION-GRANALLA

No.	Localización	Bulbo ó lámpara por candil			Horas por dia		Consumo por mes (kwh)			kW	F.B.M.	Observaciones
		No.	Tipo	Watts	Base	Punta	Base	Punta	Total	Reales		
	Exterior											
2	Recuperador de arena	1	Inc.	150	20	4	162	32	194	0.30	$61	
3	Recuperador de arena	2	Fl	75	20	4	292	58	350	0.54	$110	
1	Recuperador de arena	1	A.M.	400	20	4	259	52	311	0.48	$98	
3	Torre de enfriamiento Aceración	2	Fl	75	20	4	292	58	350	0.54	$110	
5	Gerencia producción	2	Fl	75	10	2	243	49	292	0.90	$106	
3	Gerencia producción	2	Fl	39	10	2	76	15	91	0.28	$33	
1	Gerencia producción	1	Inc.	200	2	0	11	0	11	0.20	$9	
2	Dpto. de seguridad industrial	2	Fl	39	10	2	51	10	61	0.19	$22	
8	Comedor	2	Fl	39	20	4	404	81	485	0.75	$153	
2	Sanitarios	1	Inc.	200	20	4	216	43	259	0.40	$82	
15	Alrededor de la nave	1	V.S.A.P.	400	10	2	1,944	389	2,333	7.20	$845	
2	Alrededor de la nave	2	V.M.	175	10	2	227	45	272	0.84	$99	
	Total						15,531.91	3,104.22	18,636.13	33.65	$6,023	

3.1.4.4 AIR COMPRESSORS

Better efficiency in the Chicago Pneumatic Compressors

A very important point to mention is that the operation temperature of this compressors is high (100° C), so the air temperature is also the same which can be reduced if the following is done:

- One of the advantages of the substitution of mineral oil by the synthetic one is the temperature decrease of the operation equipment and a longer compressors life, both compressor's parts and the compressor's working parts as well as it is going to be a longer time needed to change the oil, and it is estimated a temperature decrease of 15%.
- By temperature operation decrease, the air and the oil will have a lower temperature and the equipment will be in better conditions.

Because of the position of the current cooling system installed in Chicago compressors, it is concluded:

- Hot air goes as the compressors way, because the hot air is entering to the compressor, its condition gets worse because it is absorbing this hot air and electrical and mechanical conditions also get affected.
- This problem also affects since the compressor absorbs hot air to compress at a temperature higher than the environment as a consequence there is less material to compress and an increase in the energy consumption because of the same reason and less volumetric flow at the compressor's exit.

Better ideas to increase air quality:

- In order to improve air quality it is necessary to place, in every air entrance, a valve to automatically drain the condensed air since, currently, this activity is not done periodically in a manual way, another option could be to look for a responsible person since there is condensed accumulation in the surge tanks.
- It will be necessary to fix the compressor, so it can be used totally. It also will be necessary to fix the escapes in the distribution condensed air, to substitute the damaged tubing where necessary. It will also help to substitute the current tubing's diameter specifying at the exit of each compressor its optimal functioning and decrease losses because of exit restrictions.
- It is recommended a check valve at the exit of each compressor to avoid leaks inside because they provoke an overload.

Advantages in eliminating walls around compressors:

- Ventilation will be better, since the hot air from the equipment won't be closed, in consequence, there is going to be an operation's temperature decrease and an efficiency increase.
- Compressor's noise won't be closed, operator's conditions will be better.
- Installed extractors on that area can be eliminated and during certain season of the year, air conditioner can be also eliminated.

Better ideas to reduce compressor's noise:

- The use of synthetic oil will decrease considerable the noise generated by friction.

- Actually, the reason because noise is emitted from compressors is the way the cooling oil system works, so it is recommended to install in the other three compressors a systems similar to the one in Compressor number 2, to get a better hot air movement, locate these radiators on the compressors room ceiling since it would only be necessary to extend the entrance and exit oil lines.

Conclusion

1. The only way it can be reduced the energy consumption is decreasing compressor's pressure while operating, see the graphic that show leaks evaluation.
2. By analyzing the compressor, it is concluded that it does not decrease energy waste on consuming less air in the plant.
3. Although every leak of compressed air is sealed, it won't be a significant power saving, but the obtained benefit will be that the air previously escaping by leaks will now be available for the consuming areas.

For example if there were used three compressors before sealing leaks, it is possible that, once fixed, it will be needed only two because the air needed by the leaks might be such that another compressor would be needed so the pressure wouldn't decrease.

4.- CURRENT ENERGY SITUATION IN THERMAL AREA

4.1 HISTORIC FUEL CONSUMPTION

The next Table shows consumption registered for each period in 1995 and 1996 to date in all of FUMOSA's plant including the area under study which is the steel building.

Table 4.1.1 Historical Natural Gas Consumption at FUMOSA

Period	1995 (Nm^3 G.N.)	1996 (Nm^3G.N.)
January	572,965	609,622
February	534,982	607,605
March	592,083	590,996
April	489,432	495,874
May	437,891	520,277
June	516,834	489,310
July	541,120	514,353
August	532,622	508,806
September	488,822	
October	529,305	
November	628,747	
December	620,064	
Average	540,406	542,101
S.D.	51,431	55,938
%	9.5	10.4

This consumption handled in the above tabulation refer to the total plant. These where obtained from invoices from the gas company.

The plant does not have natural gas measurements by department or consumption center, for which steel consumption will be based on the capacity of the burners, the operation factor and time the equipment is in use during the month.

The cost of a cubic meter of gas for August 1996 was $ 0.0637 pesos even thou this value is vary variable and suffers monthly adjustments that change with international fuel prices.

In the mean time we have the average up to April 1996.

Average Monthly Consumption	542,101 m^3
Annual cost off Consumption	$ 345,318 M.N.

4.2 TOTAL INSTALLED LOAD.

Thermal Treatment Furnaces

Table 4.2.1 Burner features of each furnace.

Burner Model	Capacity	No. units/Furnace	Total Load
51 - 1A	85,400 Btu/hr	11	939,400
51 - 2C	191,000 Btu/hr	2	382,000
			1,321,400

Tabl3 4.2.2 Tabulation of installed equipment, capacity and operation factor.

Equipment	Capacity	% OPERATION	Cap. Operated	Consumption N.G.
Annealing 1	1;321,400 Btu/hr	60%	792,840 Btu/h	28.3 m^3/h
Annealing 2	1;321,400	60%	792,840	28.3
Tempered 1	1;321,400	90%	1;189,260	42.4
Tempered 2	1;321,400	90%	1,189,260	42.4
Tempered 3	1;321,400	90%	1;189,260	42.4

Data of the fuel used (Natural Gas)

Molecular Weight	17 g/mol
Specific Weight	0.602 kg/m^3
Lower Heating Power	8,640 $kCal/m^3$
	34,290 Btu/m^3

Combustion efficiency supposing acceptable parameters.

Excess Air	9%
Smoke exhaust P.	400 °C
% loss	18.2 %

So burner efficiency is 81.8 %

$$\text{N.G. Consum.} = \frac{\text{Operating Cap.}}{\text{PCI * Comb Ef.}}$$

Table 4.2.3 Fuels and Consumption Parameters.

	N.G. Cons.	Hrs. Op/month	N.G. Oper. Consumption
Annealing Furnace 1	28.27 m3/h	580	16,400 m3
Annealing Furnace 2	28.27	580	16,400
Annealing Furnace 3	∅	∅	∅
Tempering Furnace 1	42.40	620	26,300
Tempering Furnace 2	42.40	620	26,300
Tempering Furnace 3	42.40	620	26,300
Total	183.74 m3/h		111,700 m3

Load and Consumption Current Data.

FUMOSA's Natural Gas monthly Consumption 542,100 m3
Consumption % for Thermal Treatment 20.6 %
Monthly charge for natural gas consumption in the Thermal Treatment area $ 71,150 M.N.

4.3 ENERGY BALANCES

4.3.1 ARC FURNACE BALANCE.

Casting Data.

Particular casting	**Steel for Granules**
Scrap initial load	5,500 kg.
Liquid steel final product	4,900 kg.
Casting Time	118 min.
Energy Consumption	3653 kWh
Furnace specific consumption	745 kWh/Ton
Energy required for fusion	386 kWh/Ton.
Final system Efficiency	52%
Casts per Month	150 casts.

Table 4.3.1 Summary of the Balance.

Concept	**kWh/cast**	**kWh/Ton. H.F.**	**%**
a) Useful Energy	1,891	386	52
d) energy in Slag	180	37	5
c) Smoke sensible heat	294	60	8
e) Wall and Rad. heat trans.	852	173	23
b) Cooling	436	89	12
Energy supplied	3,653	745	100

*** Cost of cast in E.E. consumption $ 922 pesos/cast $ 188 pesos/Ton**

Cost per E.E. monthly consumption $ 138,000/month

* The cost includes only the charge for E.E. consumption in the base period and the fuel adjustment, this last one is in direct function to the total kWh consumed. It does not include the charge for demand that is a fixed monthly charge.

Evaluation and breakdown of energy concepts from the arc furnace balance.

a) Useful Energy.

Table 4.3.2. Iron Physical/Chemical Properties (Fe)

State	**Cp. Cal/K mol**	**Temps Interval (k)**	**% inc.**
c,a	4.13 + 0.00638T	273 - 1,041	3
c, b	6.12 + 0.00336T	1,041 - 1,179	3
c, l	8.40	1,179 - 1,674	5
c, d	10.0	1,674 - 1,803	5
l	8.15	1,803 - 1,873	5

Ref. Table 3-181 Chemical Engineer Encyclopedia, Robert H. Perry 6a. ed.

Iron Physical/Chemical Properties.

Fusion Temperature	1,530°C (1,803 K)
Fusion heat	3,560 Cal/mol
Molecular Weight	54.938 gr/mol

Ref. Table 3-177 Chemical Engineer Encyclopedia, Robert H. Perry 6a. ed.

Table 4.3.3 Iron physical/chemical states and their specific energy load.

State	Interval °C	Cal/mol	kWh/Ton	%
c,a	25 a 768	6,242	132	34
c, b	768 a 906	1,359	29	7
c, l	906 a 1,401	4,158	88	23
c, d	1,401 a 1,530	1,290	27	7
fusion	1,530	3,560	75	20
l	1,530 a 1,730	1,630	35	9
		18,239	386	100

Final product of liquid iron. 4,900 kg.

Specific consumption required for fusion. 386 kWh/Ton.

Useful Energy. 1,891kWh/cast

b) Cooling

Cooling water flow 210 GPM. (13.25 LTS/S)

Temperature Difference 4°C

Q = m Cp DT

Cp water 1 kCal/kg °C
r water 1 kg/lto.

Cooling thermal load 53 kCal/s
Cooling thermal load 222 kW
Melt time 118 min.
Total Energy dissipated through cooling per melt 436 kWh/Melt

c) Sensitive heat in smoke.

Air velocity through duct.	7 m/s
Duct inside diameter	0.75 m
Ambient temperature	32°C
Gas Temperature	80°C
Cp air at 350 k	1.0090 kV/kg °C
Air density	0.9980 kg/m^3

Mass flow of air

$$\text{Area} = \frac{P\ (DI)^2}{4}$$

$= 0.442\ m^2$

FV. = Area * Vel.
= 3.09 m^3/s (185.55 m^3/min)
= 3.086 kg/s

Thermal load

= Mass flow * Cp * DT
= 3.086 kg/s * 1.0090 kJ/kg °C * (80°C - 32°C)
= 150 kJ/s (kW)

Sensitive heat per melt. = 294 kWh/Melt

d) Energy lost in slag.

Chemical composition considered for slag

17 % in weight FeO
83% in weight CaO

Heat capacity data for each compound.

Cp CaO $10 + 0.00484\ T - 108{,}000/T^2$ *Cal/k mol 273 a 1,173 K*

PM CaO = 56.0794 g/mol

Integrating and resolving we have:

Q1 = 11,595 Cal/mol	25 a 900°C	240.4 kWh/Ton.
Q2 = 12,125 Cal/mol	900 a 1,600°C	251.4 kWh/Ton.
Qt = 23,720 Cal/mol	25 a 1,600°C	491.8 kWh/Ton.

Cp FeO *24.72 + 0.01604 T - 423,400/T² Cal/k mol* *273 a 1,097 k*

PM FeO = 70.937 g/mol

Integrating and resolving we have:

Q1 = 27,270 Cal/mol	25 a 824°C	446.8 kWh/Ton.
Q2 = 37,507 Cal/mol	824 a 1,600°C	614.5 kWh/Ton.
Qt = 64,777 Cal/mol	25 a 1,600°C	1,061.3 kWh/Ton.

The estimated Heat Power for slag is 588.6 kWh/Ton

With a de-slagging of 300 Kg per melt aprox.

The energy quantity for this concept is 180 kWh per melt or 37 kWh/Ton.

Scrap heating analysis.

Table 4.3.4 Energy required to take the scrap from 25°C to 800°C.

Initial T	Final T	Acum. Energy		%
25°C	500°C	3,585 Cal/mol	75.9 kWh/Ton.	20
	600°C	4,523	95.7	25
	700°C	5,525	116.9	30
	800°C	6,552	138.7	36

Total load.				
25°C	1,730 °C	18,239.5	386.0	100

From this analysis we conclude that 30% to 36% of the energy required to melt iron can be provided by a different kind of previous heating. This implies taking the raw material (scrap) to a temperature of 800° to 900° C at the start of the melt.

For calculation purposes we will use 800°C as a reasonable approximation throughout this analysis.

Initial data.

Energy per melt	3,653 kWh/melt or 745 kWh/ton.	
Energy required for melting	1,891 kWh/melt or 386 kWh/Ton.	
Process Efficiency	52%	
Aprox. No. of melt per month	150 coladas	
Cost of melt by consumption and fuel adjustment	$ 922/melt	$ 188/Ton.
Monthly fixed charge by furnace demand	$ 34,230 pesos M.N.	
Monthly cost by consumption and fuel adjustment	$ 138,000 pesos M.N.	
Average duration of melt	8 minutes.	

In case that energy requirements for iron can be lowered 36% in the furnace, analyzing the balance we can decipher the impact that other energy concepts will suffer.

Table 4.3.5 Summary Melt balance

Concept	Impact
a) useful energy	directly proportional
b) Cooling	directly proportional
c) Smoke sensitive heat	directly proportional
d) Slag lost energy	null
e) Wall Heat Trans.	directly proportional

As can be seen, reducing the energy supplied to the furnace, the melting time is reduced and also the energy concepts that are a function of time as is the case of cooling required, the sensitive heat lost in smoke and energy losses by heat transfer on walls.

The energy required by slag removal is not affected since this concept is related to raw material, iron oxide, sand, etc. that are present.

Table 4.3.6 Impact of energy reduction in the melt balance.

Concept	kWh/ton	Impact	Final
a) Useful energy	386	139	247
b) Cooling	89	32	57
c) Smoke sensitive heat	60	21	39
d) Energy lost with slag	37	0	37
e) Wall heat transfer.	173	62	111
Supplied energy	745	254	491

So we have that the melt will consume 491 kWh/ton. and having 4.9 tons of melted iron we get 2,406 kWh/melt. 34% less energy related to current consumption.

Table 4.3.7 Approximate monthly consumption.

	Monthly Consumption	Cons. Charges F.Aj * Comb.
Current	548,000 kWh	$ 138,000 M.N.
Expected	361,000 kWh	$ 91,000 M.N.
Difference	187,000 kWh	$ 47,000 M.N.

Charge for Natural Gas Energy.

Primary energy charge.	138.7 kWh/ton
(4.9 ton/melt)	680 kWh/load
Monthly energy required	102,000 kWh/month.

Natural Gas Consumption.

Mexican natural gas properties.

Parameters	Typical Analysis
Methane, % weight	92.3
Ethane, % weight	6.3
Propane, % weight	1.4
Sulfuric acid, ppm	3.5
Molecular weight	17
Specific weight	0.602
Lower heating power , $KCal/m^3$	8,640 **

** Measured at 5.6°C y 760 mm de Hg conditions.
Characteristics are affected by underground conditions at the locations where it is extracted so its composition varies from some deposits to others and their heat power oscillates from 7,467 to 9,333 $kCal/m^3$

Transporting energy units

Monthly required energy	102,000 kWh/month
	88,000 Mcal/month

Efficiency expected by combustion and heating 70%

Natural Gas Excpected Consumption.

$$G.N. (m3) = \frac{E\ (kCal/\ month)}{PCI\ GN\ (Kcal/m^3)\ Efic., (ad)\ )}$$

$$G.N. (m3) = \frac{88{,}000{,}000\ kCal/month}{8{,}640\ kCal/m^3 * 0.7}$$

$$= 14{,}550\ m^3/\ month$$

Natural gas cost August 1996 \$ 0.6370 per Nm^3

Natural gas consumption estimated cost	\$ 9,270 per month
Real hours of system operation.	280 hrs.
electric energy consumption	3 hp.
	\$ 226.22 per month

Total operation monthly cost **\$ 9,496 per month**

Dust collectors operation.

OPERATION dust collector system	15 hp´s
Demand	$ 30.401 per kW
Consumption and fuel adjustment	$ 0.25249 per kWh.

Charges	$ 340.10	demand
	$ 790.90	consumption and adjustment

Total $ 1,131.0

Cost and benefit balance

Expected benefit	$ 47,000.0
operation cost for combustion system	$ 9, 496.0
OPERATION cost for dust collector system	$ 1,131.0
Approximate final net benefit	**$ 36,373.0**

4.3.2. COOLING SYSTEMS (DESCRIPTION)

Cooling tower Furnace W-1 and W-2 and degassed furnace

Tower parameters.

Water flow to towers	520 GPM (118,100 hs/hr)
Tower inlet Temp.	37.5 °C
Temp. at tower container	33.5 °C
Thermal load at towers	156 TR

Table 4.3.8 System's electric energy consumption.

	F.B.M.	H.P.	K.W.
Pump 1	2,871.58	20	14.06
Pump 2	2,819.50	20	13.80
Pump 3	0.00	25	0.00
Pump 4	4,399.43	40	21.54
Pump 5	4,140.54	40	20.27
East Fan	1025.95	Inaccessible	5.02
West Fan	993.83	Inaccessible	4.87
Tank W-1 B-1	380.53	7.5	3.44
Tank W-1 B-2	730.44	7.5	6.61
	$ 17,361.8		89.61

Cooling ratio 1.79 TR/KW

Design data each tower

Flow per tower 250 GPM (500 GPM Total) 113,560 hs/hr
tower temp Delta 10°C
Tower thermal load 375 TR
Capacity descent 58 %

Cooling system conclusions
* The electric energy charge or F.B.M. is to high top be only one cooling system, Analyzing the system we became aware that a lot of energy is wasted in repumping from one tank to the other, we have to think in a redistribution of the system or a total renovation or even a change in technology

* Another important point that would be good to correct having the above deficiency, is scale problems, since the current cooling system is not an isolated system. The refrigerating fluid evaporates going through the cooling towers and looses heat picked up at the heat sources, over time salts diluted in the fluid (SDT) accumulate and it is easier for scales to appear inside cooling pipes and ducts, reducing the useful life of the parts of the equipment.

* Cooling towers are very deteriorated, they lack the distribution panel, fog trap, and require urgent maintenance, this is reflected in the high temperature level at the wet bulb where they are currently working and the short temperature difference they generate.

Cooling tower Granule Pit.

Parameters found at the towers.

Flow analysis.

q_1 = 1,130 GPM (71.3 Hs/s)
q_2 = 2,270 GPM (143 Hs/s)

Operating temperatures.

Ambient Tbs = 27°C
Tbh = 20°C

T_1 Upper tower temp. = 35°C
T_2 Lower tower temp = 30.4°C

* Tower capacity.
Thermal load removed.

$Q = q_1 \, Cp \, DT$

q_1	71.3 lts/s
Cp	1 KCal/Kg°C
r	1 kg/lto.
DT	4.6°C

Q = 390 TR

Thermal load at the granule pit and tempering fumes.

Thermal load calculation

Granule pit data
1.63×10^6 kCal/melt" energy dissipated by melted iron as it cools"
Energy present in 4.9 tons of melted iron at 1,730°C

Thermal load = 375 TR per 13 hs as maximum
Maximum 9 melt per day.

Tempering data

1.25 Ton/h
Temp. of granule 900°C
Accumulated Energy 161 kWh/Ton of red granules .
Thermal load 60 TR.
Total maximum thermal load of the system to cool 460 TR

System balance.

Daily thermal load.

Cooling tower	390 TR.	28.3 x 106 Kcal/día
Granule pit and tempering	9 melts	14.7 X 106 Kcal/día
	60 TR.	4.4 X 106 Kcal/día
	Total	19.1 X 106 Kcal/día.

Thermal load at the cooling tower is insufficient at first, but in the balance of the operation it is enough and even exceeds so constant operation is not necessary.

Table 4.3.9 Thermal load distribution

	Load	Time	%
Tower's useful load	19.1 X 10^6 KCal/día	16.2 hrs.	70
Excess tower load	9.2 X 10^6 KCal/día	7.8 hrs.	30
Total load	28.3 X 10^6 KCal/día	24 hrs.	100

So only a 70% of the time is useful and the other 30% is wasted in pumping.

System's operating cost.

	H.P.	kW	F.B.M.
Pump 1	50	33.16	$ 6,773.32
Pump 2	50	31.84	$ 6,504.72
Pump 3	50	24.54	$ 5,013.44
Fan	X	4.93	$ 1,006.88
			$ 19,298.36

Conclusions:

- The same as with the arc furnace cooling system, this system appears to be inadequate in design and currently suffers a grate deterioration on the inside due to lack of preventive maintenance and consequently the operating cost is to high because it is continuously operating and does not have any controls or parameters to control.

- Another point detected in this system is that the current tower does not have enough capacity since it has been surpassed by the system's cooling demand and requires a given time to reach equilibrium or else the process must be suspended.

- The deficient capacity and pipe layout for pumping definitively prevents the possibility to shut off or reduce the system's operation at low load periods, thus preventing power savings or a more efficient use according to requirements through time. In other words, the system operates at 100% or doesn't regardless of the cooling requirements of the system.

.3.3. Thermal Treatment Furnaces.

Thermal treatment data .

Sample date 10 de October de 1996
Time of sample 11:00 a 12:00 hrs.

Gas Analysis Tempering furnaces

Parameter	Furnace 1	Furnace 2	Furnace 3
02, $	9.3	8.4	2.7
CO2, %	6.3	6.9	9.6
Exhaust temp, °C	470	640	806
Comb.	0.0	0.1	0.1
CO, ppm	115	40	175
Ef., %	57	54	60

Gas Analysis Annealing Furnaces .

Parameter	Furnace 1	Furnace 2
02, $	13.4	18.5
CO2, %	4.2	1.3
Exhaust temp, °C	416	240
Comb.	0.0	0.4
CO, ppm	0.0	786
Ef., %	55	21

* Measuring equipment Teledyne Max. 5.

Conclusions:

As can be seen, the simple combustion of all five equipment is extremely low so it is necessary to apply corrective measures, the most important items to correct are losses through high temperature smoke and bad burner tune-up. This report includes a savings card which analyzes saving perspectives that can be achieved by fixing these deficiencies.

5.- ENERGY SAVINGS TICKETS

SAVINGS CARD No. 01

AREA: STEEL FOUNDRY.

NAME :

Development of statistical analysis in arc furnace W-1 y W-2, in the steel area

SUMMARY TABLE

Annual Savings:	**$ 181,792**
Monthly savings:	**$ 15,150**
Investment cost:,	**NULL**
Return on investment:	**IMMEDIATE**
Demand Savings:	**0 kW**
Consumption Savings:	**0 kWhp**
	60,000 kWhb
Savings % F.B.M.	**5.55 %**

1.- CONCRETE AREA

To implement this savings measure it is necessary to perform the following activities.

a).- Develop a statistical analysis on the arc furnaces area, primarily in the operative practice of the same.

b).- Perform training and awareness programs for involved personnel, on the benefits obtained through standardization of operative furnace practices.

c).- Have a reliable electric measuring system, such as to have an exact measure of consumption per melt and to see the benefits directly.

2.- DESCRIPTION AND BACKGROUND

Within the steel area there are two arc furnaces, which operate on third and firs shifts (23:00 to 7:00 to 15:00). As part of the energy diagnosis performed in this area, a statistical analysis war made on the actual way they operate these furnaces.

The analysis covered collection over three months on the information in the fusion reports, obtaining data such as : date, melt quantity, kind of steel, melt duration, energy consumption, metal load, delay time, etc.

Later, statistical test were performed to clean information that cold be outside normal operation limits.

Last, we started to analyze the results to establish operative improvement items and practices to reduce electric energy consumption by melt (kWh/TCM).

From the results of this analysis we could obtain improvement areas as to the operative form of the furnaces, these are .

- With melt sheets it is important to have assurances on their content and that they at analyzed daily by management and operations, so that faults of that day do not repeat the next, this shall have the potential to reduce more than half of the standard deviation of the electric consumption (20 kWh/TCM aprox).
- There was a difference of more than 20 kWh/TCM between one furnaceman and the other for granule production and this was repetitive. The other furnaceman had an improvement in kWh/TCM for special steel production better than 16 and this was repetitive. So if a training program is carried out for both furnacemen, there will be this improvement in expected consumption.
- If they get to have a reliable measuring system, this could be used to optimize operative practices proposed and thus getting an additional benefit around 40 kWh/TCM.

3.- BENEFITS

In conclusion of the results of the analysis we could get areas for improvement with respect to furnace operation, to decrease energy consumption by melt of around 80 kWh/TCM aprox.

The savings obtained are only consumption and fuel adjustment, this is :

Taking 80 kWhb/TCM as saving base:

We consider an average load of 5 tons/load and 150 tons per month, so:

TCM/-month = (5 Tons)*(150 melts/month)

TCM/month= 750 TCM/month

With this ton average per month by 80 kWh/TCM we have:

kWh/month saving = (80kWh/TCM)*(750 TCM/month)

kWh/month saving = 60,000 kWhb

Supposing that all is consumed in this base period, we have:

Savings = (60,000kWh/month)*($ .1584)

Savings = $ 9,504 /month

On the fuel adjustment concept we have:

Savings = (60,000 kWh/month)*($ .09409)

Savings = $ 5,645

total savings would be the sum of consumption plus savings in fuel adjustment:

Total Savings = $ 9,504 + $ 5,645

Total Savings = $ 15,149 /month

Annual Savings = $ 15,149 /month * 12 months

Annual Savings = $ 181,792

% de la F.B.M. = $ 181,792 / $272,597 * 100

% de la F.B.M. = 5.55

* F.B.M. = Monthly Basic invoicing

4.- INVESTMENT COST.

Investment required to implement this measure is considered marginal by being only changes in operative practices and in training programs for operation personnel.

5.- RETURN ON INVESTMENT.

Simple return on investment is immediate since it is a measure without investment.

6.- TECHNICAL CONTEXT.

Performing all recommendations and actions, there is no technical risk associated with the implementation of this savings measure; only an adequate planing on production, training and maintenance.

7.- ACTION PLAN.

We recommend performing the implementation as soon as possible, to start receiving savings.

SAVING CARD Nº 02

AREA: STEAL MILL MELTING

Name:

Take the steal mill area out of operation in the pick hours.

Summary table

Annual saving	$12,624
Monthly saving	$ 1,052
Investment cost	---
Investment payback	Immediate
Demand saving	30 kW
Consumption saving	0 kWpick hour 0 kWbase hour
% Saving of F.B.M.	.40%

1.- ACTUAL ACTION

To implant this saving choice it is necessary to make the following:

a) Take the sand recovery area out of operation in pick hours during the month.
b) Work during base hours in the sand production area so it can be fulfilled the production goal of its intern client (gray iron)
c) Carry out action plans to eliminate obstacles, delays, faults, etc., in the process.
d) The maintenance department (electric and mechanic) has to compromise of planning and make preventive and corrective maintenance programs.
e) Train the personnel of the involved areas.

2.- DESCRIPTION AND BACKGROUND

Nowadays, the sand recovery area is working 24 hours a day divided in three shifts. Therefore it works during the pick hours in consumption and demand.

After searching the areas and their ways of operation, it was found that this area has a rate production of 6 to 10 tons of recovered sand each shift. So, approximately it produces 26 to 30 tons per day.

Production requirement of the gray iron area does not exceed 15 tons of sand per day. Therefore, it would be necessary to reprogram the schedule of each shift and do not work during the pick hours (Monday to Saturday 18:00 - 22:00)

To carry out actions the maintenance department has to schedule its dues during this time (critic hours) and guarantee the maintenance given to the equipment of each area so they take *maximum advantage of base hours and do not have to use critic hours because of faults, delays or* any problem.

3.- BENEFITS

Since sand recovering area will have to consume the critic hours energy in the first and third shift the resulting savings will be demand savings because of the difference in consumption costs between base hours and pick hours.

Taking the 30 kW of demand as base.

Saving kW: (30 kW (.8) = 24 kW
(.8) factor is because of C.F.E. billing

Demand Saving: (24 kW) ($30.41)
Demand Saving: $730 / month

Consumption saving will be the difference in costs between pick hours and base hours.

Consumption saving: (4h) 27 days / month) (30 kW)
Consumption saving: 3,240 kWh

Cost in base hour: (3,240 kWh) ($.1584/kWbase h)
Cost in base hour = $821.01

Cost in pick hour: (3240 kWh)($.2534/kWpick h)
Cost in pick hour = $ 821.01

Consumption saving: =$821.01 - (.2534 / kWpick h)
Consumption saving: =$307.80 / month

Total saving: =$730 + $307.80
Total saving: =($1,037.80) / month

Annual saving: =($1,037.80) (12 months)

Annual saving: =$12,453.6

Monthly basic billing percentage = Total saving / F.B.M. * 100

F.B.M. % = $1,037.80 / $272,597 * 100
F.B.M. % = .40

4.- INVESTMENT COST

Investment is not required to implement this choice because there will be made just operative changes,

5.- INVESTMENT PAYBACK

Investment payback is immediate because this is a non-investment option

6.- TECHNICAL CONTEXT

If every action and recommendation is carried out, there is no risk associated with the implementation of this saving action. It is necessary to follow an appropriate planning of production and maintenance to avoid intervals caused by human faults or programming faults that keep from savings.

7.- ACTION PLAN

It is recommended to implement this action as soon as possible to start getting savings.

SAVING CARD No. 03

AREA: STEEL AND GRANULES.

NAME:

Awareness and training for personnel and implementation of EN-3 system's ideas and improvements.

SUMMARY TABLE

Annual Savings:	**$ 9,812**
Monthly savings:	**$ 817.75**
investment cost :,	**NULL**
Return on Investment:	**IMMEDIATE**
Savings on Demand :	**0 kW**
Savings in Consumption:	**0 kWhp**
	5,162 kWhb
Savings % F.B.M.	**.47 %**

1.- CONCRETE ACTION

To implement this measure it is necessary to perform the following activities

a).- Perform implementation plans on the ideas and improvements system EN-3

b).- Schedule awareness talks to all personnel at FUMOSA

c).- Establish measuring systems, that allow a view of improvements in energy savings.

2.- DESCRIPTION AND BACKGROUND

One of the most important energy saving potentials in energy diagnostics is the involvement and believe of the people working in the company. Without this kind of support it is impossible for the diagnosis results to be real. To these effect, several activities were performed towards involving, convincing and participation of FUMOSA personnel. Among these activities :

- Ideas and improvement system EN-3
- Awareness talks to personnel
- Convincing of the benefits in energy saving and it importance to the whole country.

3.- BENEFITS

From these kind of methodologies we could estimate a savings through awareness and involvement of the people in the steel area at FUMOSA

Considering an estimated savings of 5,162 kWh/month in actions such as: consume only necessary energy, turn off equipment when its operation is not necessary, optimize motor usage, illumination equipment, etc. we have :

Considering 6,276 kWh/month:

Consumption savings = (5,162 kWh/month)*($ .1584)

Consumption savings = $ 814.66 /month

Savings by fuel adjustment = (5,162 kWh/month)*($ .09409)

Savings by fuel adjustment = $ 485.7

Total Savings= Consumption savings + Fuel adj. savings

Total Savings = $814.66 + $485.7

Total Savings = $1,300.36

% de la F.B.M. = $1,300.36 / $272,597 * 100

% de la F.B.M. = .47

4.- INVESTMENT COST .

Investment required to implement this measure is considered marginal since it only means operation practices and training session for personnel

5.- RETURN ON INVESTMENT.

Simple return on investment is immediate since it is a measure without investment.

6.- TECHNICAL CONTEXT.

Performing all recommendations and actions, there is no technical risk associated with the implementation of this savings measure; only an adequate planing on production, training and maintenance.

7.- ACTION PLAN.

We recommend performing the implementation as soon as possible, to start receiving savings.

Note: In chapter 6.1 we make a specific reference to the application method of EN-3 system and results obtained by the same.

SAVING CARD Nº 04

AREA: TEMPERING AND GRANULATED METAL

Name:

Lighting efficiency in different parts of the plant areas.

Summary table:

Annual saving	$ 22,812.00
Monthly saving	$1,901.00
Investment cost	$52,150.00
Investment payback	2.28 years
Demand saving	0.0 kW
Consumption kWbase h/month saving	5,907 1,179 kWpick h/month
% F.B.M.	0.70%

1.- ACTUAL ACTION

Keep every kind of lighting turned off when it is not necessary in the different plant areas, according to the attached calculate sheets

2.- DESCRIPTION AND BACKGROUND

Nowadays, there are a lot of kinds of lighting (high discharge, fluorescent and incandescent) which remain turned on 24 hours a day since the natural lighting is not well used because of the acrylic lamina in the plant, so it is suggested to renew this acrylic lamina so the mentioned lighting could be turned off.

According to the above, it is recommended to install an automatic control (Photocell, timer, etc.) or perfectly identify the switches in the power centers to turn them on just when lighting is necessary.

The attached tables show the number of lamps which are turned on during the estimated number of hours and here it can be noticed the proposed future performance using this choice.

3.- BENEFITS

The annual saving associated with the use of this choice is:
$ 22,812.00

The calculus to get these billing parameters are described as follows:

DEMAND

$$\text{kWdemand} = (\text{ballast lost} * \text{N}^{\circ}\text{ of lamps} * \text{Watts/lamps}) * \frac{1\text{kW}}{1000\text{ Watts}}$$

kWbilling demand = (0.8) (kW pick hour) + (0.2) (kW base hour)

CONSUMPTION

kWbase hour = kWmax. demand in base hour * base hours/month
= (kWmax. demand in base hour * 27 days per month * base hours a day)

kWpick hour = kWmax. demand in pick hour * pick hours/month
= (kWmax. demand in pick hour * 27 days per month * pick hours a day)

Obtained benefits are the result of the difference of current conditions Vs implementation conditions multiplied by the rate cost of each parameter.

DEMAND

Demand saving = (kWcurrent demand - kWfuture demand) * (cost kWdemand)
= (21.03 - 21.03) $30.401
= $ 0/month

CONSUMPTION

Savings in:

kWbase hour = (kWbase hour saving) (kWbase hour cost)
= (11,356 - 5,449) 0.1584
= $ 935.67/month

kWpick hour = (kWpick hour saving) (kWpick hour cost)
= (2271 - 1,902) 0.25334
= $ 298.67/month

F.A.C. = (Sum of the difference in consumption saving) (F.A.C. cost)
= (Total current consumption - total future consumption) (F.A.C. cost)
= (13.627 - 6,541) $ 0.09409
= $ 666.72/month

Total monthly saving = $ 1,901.00
Total annual saving = $22,812.00

The percentage of the total saving of this lighting choice regarding the F.B.M. is:

% F.B.M.= (total saving per month / F.B.M.) * 100%
= ($ 1,901 / 272,597) * 100
= 0.70%

Note: The lighting of some other areas of the tempering and granulated metal department has been included. Such areas are not situated exactly in the acrylic lamina area. But since its saving is minimum, it is considered not to affect the investment payback.

4.- INVESTMENT COST.

In this saving choice we considered the renewal of the acrylic lamina located in the sealing of the plant and quoted in m2.

Amount	Dimension (m)	Total (m2)	m2 Cost	Total
7 groups	2.46 x 2.80	48.21	$ 200.00	$ 9,642.00

18 groups	2.46 x 4.80	212.54	$ 200.00	$ 42,508.00
				$ 52,150.00

5.- INVESTMENT PAYBACK

The investment payback is as follows:

$$ROI = \frac{\text{Investment}}{\text{saving}} = \frac{\$\ 52,150.00}{\$\ 1,901.00} = 27.43 \text{ months} \quad 2.28 \text{ years}$$

6.- TECHNICAL CONTEXT

The acrylic lamina maintenance is very important because it extends its working life and so the energy saving.

There is not technical risk with the implant of this saving choice.

7.- ACTION PLAN

ACTION	WEEKS
Refine attachment	0.5
Investment authorization	1
Material requirement	0.5
Material arrival	4
Installation	2

ILUMINACION
FUMOSA, AREA ACERACION-GRANALLA

No.	Localización	Bulbo ó lámpara por candil			Horas por día		Consumo por mes (kwh)			kW	F.B.M.	Observaciones
		No.	Tipo	Watts	Base	Punta	Base	Punta	Total	Reales		
	Nave de Aceración											
5	Nave	1	A.M.	400	20	4	1,037	207	1,244	1.92	$392	1 no funciona
11	Nave	1	V.M.	400	20	4	1,555	311	1,866	2.88	$588	5 no funcionan
14	Nave	1	V.S.A.P.	400	20	4	3,629	726	4,355	6.72	$1,373	
2	Cuarto de control horno W 2	2	Fl	75	20	4	194	39	233	0.36	$74	
4	Cuarto subestación gruas	2	Fl	75	20	4	292	58	350	0.54	$110	1 no funciona
9	Cuarto de motores desgasificado	2	Fl	75	20	4	486	97	583	0.90	$184	4 no funcionan
1	Cuarto de motores desgasificado	1	A.M.	400	20	4	259	52	311	0.48	$98	
1	Cabina de control horno de olla	2	Fl	75	20	4	97	19	117	0.18	$37	
2	Cuarto de control horno W 1	2	Fl	75	20	4	194	39	233	0.36	$74	
4	Cuarto subestación horno W 1	2	Fl	75	20	4	97	19	117	0.18	$37	3 no funcionan
8	Gruas	1	Inc.	200	20	4	648	130	778	1.20	$245	2 no funcionan
2	Gruas	2	Fl	75	20	4	194	39	233	0.36	$74	
	Nave de Granalla											
5	Nave	1	V.S.A.P.	75	20	4	243	49	292	0.45	$92	
8	Nave	1	A.M.	75	20	4	243	49	292	0.45	$92	3 no funcionan
5	Nave	1	V.M.	75	20	4	146	29	175	0.27	$55	2 no funcionan
1	Nave	2	Fl	75	20	4	97	19	117	0.18	$37	
2	Cuarto de control	2	Fl	75	20	4	194	39	233	0.36	$74	
1	Oficina	2	Fl	75	20	4	97	19	117	0.18	$37	
1	Sanitario	2	Fl	75	20	4	97	19	117	0.18	$37	

ILUMINACION
FUMOSA, AREA ACERACION-GRANALLA

No.	Localización	Bulbo ó lámpara por candil			Horas por dia		Consumo por mes (kwh)			kW	F.B.M.	Observaciones
		No.	Tipo	Watts	Base	Punta	Base	Punta	Total	Reales		
	Exterior											
2	Recuperador de arena	1	Inc.	150	20	4	162	32	194	0.30	$61	
3	Recuperador de arena	2	Fl	75	20	4	292	58	350	0.54	$110	
1	Recuperador de arena	1	A.M.	400	20	4	259	52	311	0.48	$98	
3	Torre de enfriamiento Aceración	2	Fl	75	20	4	292	58	350	0.54	$110	
5	Gerencia producción	2	Fl	75	10	2	243	49	292	0.90	$106	
3	Gerencia producción	2	Fl	39	10	2	76	15	91	0.28	$33	
1	Gerencia producción	1	Inc.	200	2	0	11	0	11	0.20	$9	
2	Dpto. de seguridad industrial	2	Fl	39	10	2	51	10	61	0.19	$22	
8	Comedor	2	Fl	39	20	4	404	81	485	0.75	$153	
2	Sanitarios	1	Inc.	200	20	4	216	43	259	0.40	$82	
15	Alrededor de la nave	1	V.S.A.P.	400	10	2	1,944	389	2,333	7.20	$845	
2	Alrededor de la nave	2	V.M.	175	10	2	227	45	272	0.84	$99	
	Total						13,976.71	2,793.18	16,769.89	30.77	$5,435	

Energy Saving Card No 5
Thermal Area

NAME:

Scrap preheating.

SUMMARY CHART

Annual cost savings	$ 388,000.00 M.N.
investment Cost	$ 2,500,000.00 M.N.
Recovery Period	6.5 years
% Savings in Base Monthly Invoice	12%

F.B.M. = $ 272,597 M.N.

1.- CONCRETE ACTION

We propose the complete change in the current iron smelting process with electric arc, by a process that includes raw material "scrap" pre-heating with natural gas to be later melted in the same electric arc furnaces.

2.- DESCRIPTION AND BACKGROUND.

The basis for this study relies on the feasibility of heating up scrap to a moderate temperature, through natural gas combustion in stead of using entirely electric energy. taking advantage of the difference in cost between the two energies. For this reason, at a glance there is no visible savings since it is only a change in energy, using approximately the same consumption.

Currently and in average each melt process consumes 745 kWh/Ton of liquid iron, this energy is total supplied be electric energy, whose cost is higher that that of natural gas.

On the other hand, making the necessary analysis it can be determined that 36% of the energy required to melt iron, is needed to heat the material from a starting temperature of 25°C up to 800°C, and it can be provided through a cheaper energy source such as natural gas.

For this reason we propose a complete analysis including concept, basic and detail engineering, to determine the benefits obtained and infrastructure cost this measure requires for this project to be done.

3.- BENEFITS.

In this space we again cite the complete analysis developed in section 4.2.1. which determines monthly savings and costs incurred by the new system's operation.

Scrap heating.

Energy required to take the scrap from 25°C to 800°C.

T Initial	T Final	Cal/mol	kWh/Ton	%
25°C	500°C	3,585	75.9	20
	600°C	4,523	95.7	25
	700°C	5,525	116.9	30
	800°C	6,552	138.7	36

Total load				
25°C	1,730 °C	18,239.5	386.0	100

From this analysis we concluded that between 30 and 36% of the required energy for the smelting of iron can be susbtituted by another form of heating. This means to take the raw material (acrap) to a temeperature between 700 to 800 °C at the start of the melt.

To make calculations we will take the 800°C temperature as reasonable for the development of the present analysis.
Initial Data .

Energy by melt	3,653 kWh/melt or 745 kWh/ton.
Energy requiered to melt	1,891 kWh/melt or 386 kWh/Ton.
Eficiency of the process	52%
Approximated number of meltsper month	150 coladas
Cost of the melt adjusted	$ 922/colada $ 188/Ton.
Fixed monthly charges per demand for furnaces	$ 34,230 pesos M.N.
Monthly cost for comsumption and adj, comb.	$ 138,000 pesos M.N.
Average time per melt.	118 minutos.

Inthe event of reducing in 36% the need of energy by the iron in the furnace, analysing the balance it can be calculated the impact that the other items of energy.

Summary table of balance per melt.

Concept	Impact
a) Usefull energy	directly proportional
b) Cooling	directly proportional I
c) Heat sensible to smoke	directly proportional I
d) Enery lost in scrap	null
e) Transf. of heat to walls	directly proportional I

As it can be seen when reducing theenergy required bythe furnace, the time of melt is also reduced and equally the items of energy that are in function of time sucha a the cooling required, the sensible heat lost by the smoke and the lost of energy due to transfer of heat by walls

The energy lost by scrap is not affected since this item is in function of the quality of the raw material, the iron oxides, sand, etc. that are present in the melt..

Impact of the reduction of energy inthe melt balance.

Concept	kWh/ton	Impact	Final
a) Useful energy	386	139	247
b) Cooling	89	32	57
c) Heat sensible by smoke	60	21	39
d) Energy lost in scrap	37	0	37
e) Transf. of heat by walls	173	62	111
Energy provided	745	254	491

Such been the case and in short we have that the melt will use 491 kWh/ton. that at the end having 4.9 ton of iron melted we have that it would provided 2,406 kWh/melt a 34% less energy in relation to what is used at present times.

Approximate monthly usage.

	Monthly usage	Charge for F.Aj * Comb.
Actual	548,000 kWh	$ 138,000 M.N.
Expected	361,000 kWh	$ 91,000 M.N.
Difference	187,000 kWh	$ 47,000 M.N.

Charges for energy in Natural Gas.

Primary energy load.	138.7 kWh/ton
(4.9 ton/melt)	680 kWh/load
Monthly energy required.	102,000 kWh/month.

Natural gas usage.

Properties of the Mexican natural gas.

Parameters	**typical analysis**
Methane, % weight	92.3
Ethanoe, % weight	6.3
Propane, % weight	1.4
Sulphuric accid, ppm	3.5
Molecular weight	17
Specific weight	0.602
Lower heathing power, $KCal/m^3$	8,640 **

** Measured at 5.6°C and 760 mm de Hg.

The characteristics are affected by the conditions of the subsoil , the places where the gas is drawn, so its composition varies from en field to another and its heath power oscilates between 7,467 to 9,333 $Kcal/m^3$

Transforming s the energy units.

Monthly energy required. 102,000 kWh/month
88,000 MCal/month

Effeciency expected from combustion and heathing 70%

Expected comsumption of Natural Gas.

$$G.N. (m^3) = \frac{E\ (kCal/month)}{PCI\ GN\ (kCal/m^3)\ Efic.,\ (ad)\ )}$$

$$G.N. (m^3) = \frac{88{,}000{,}000\ kCal/month}{8{,}640\ kCal/m^3 * 0.7}$$

$$= 14{,}550\ m^3/month$$

Price of Natural Gas August 1996 \$ 0.6370 $/Nm^3$

Estimated cost for the comsumption of Natural Gas.	$ 9,270 montly
Actual hours of operation of the system	280 hrs.
Usage of electric energy.	3 hp.
	$ 226.22 monthly
Monthly total operation cost.l	$ 9,496 monthly

Dust colectorsystem operating 15 hp´s

Demand	$ 30.401 por kW
Usage and adjustment for combustible	$ 0.25249 por kWh.

Charges \$ 340.10 demand
\$ 790.90 Usage and adjustment.
Total \$ 1,131.0

Costs and benefits balance

Benefit	$ 47,000.0
Operation cost of combustion system	$ 9, 496.0
Operation cost of dust control system	$ 1,131.0
Aproximated final net benefit	**$ 36,373.0**

4.- COST OF INVESTMENT

To obtain a certain aproximation of the cost of the investment, it is necesssary to separate by items or units all the proyect, evaluate every one of them, sum them and finally add a factor for unforseens. With this we will have a better aproximation.

Engineering cost	25,000 USD
Burnersand auxiliary equipment	to be estimated
Electonic Controls	50,000 USD
Body of the furnace with insulation	to be defined

Aproximated initial investment 300,000 USD
at a rate of exchange of $ 8.3 /USD we will have a coost in Mexican currency of $ 2,500,000 pesos
.

5.- Simple R.O.I. = 80 meses ó 6.5 años

6.- TECHNICAL CONTEXT AND ACTION PLAN.

This item requires a greater depth for which it is necessary to make an study about this concept..

SAVING CARD Nº 06

AREA: WHOLE PLANT

Name:

Substitution of mineral oil by high efficient synthetic oil in air compressors.

Summary table:

Annual saving	$32,928
Monthly saving	$2,744
Investment Cost	$23,600
Investment Payback	8.6 months
Demand saving	0 kW
Consumption saving	9,041 kWbase h/month 1,330 kWpick h/month
% F.B.M.	1.0%

1.- ACTUAL ACTION

Change the mineral oil, currently used to lubricate the main compression equipment in the whole plant, by the Royal Purple synthetic lubricant which, in comparison with the one used, offers quite a lot of additional advantages.

2.- DESCRIPTION AND BACKGROUND

Among the different damaging phenomena which attack the energetic efficiency, the mechanical friction is one of the most important. Through time, this physical phenomenon has been recognized as an important energy consumer, being responsible of a great lose of energy in every physical process related with movement.

Here and now, energetic losses by friction are still very important. The kind of equipment and its condition are determinants for the rate of efficiency.

The more common solution found until now, in order to reduce the mechanical friction effects, is the use of lubricants. Lubricants can help two moving solid surfaces to move easily.

Companies, nowadays, are better using mineral oils and greases. But since lubricants have been improved through the time and by technological advances reached in lubrication field, synthetic lubricants have emerged and offer more advantages than the mineral ones. Besides, when it is combined with a high technology additive, it makes a high performance/additive system. All these characteristics belong to Royal Purple synthetic lubricants.

The common characteristic of synthetic lubricants is that they are made by man; their molecular structure is based on chemical processes so they are controlled and their properties can be predicted. In contrast, mineral oil is made of a mixture of different hydrocarbons with different molecular structures.

The resulting synergy of an appropriate lubricant/additive system combines all the desirable lubricant performance properties and also the ability to make an ionic exchange in the surfaces material, fitting it to really lower the coefficient of friction and get less vibration and energy wasting.

Substituting the oil has the following main advantages:

- Maximum film strength: an elastic-hydrodynamic film prevents the metal-metal contact and avoids damage, wear and an increase of coefficient of friction, getting as a result less operation temperature, an increase of the equipment performance and energy saving.
- Synerlec: a stronger ionic synthetic film licensed by Royal Purple.
- Energy saving: Royal Purple synthetic molecules are dense and closed, so they strongly stick to the metal, decreasing the coefficient of friction between the surfaces in contact. This is the main cause by which electric energy saving occurs, since there is less friction and of course less effort in both: starting and continued functioning.
- Emulsification with water: it separates rapidly from water to remain dry, there are no water-oil combinations (emulsions), extending the life of bearings. Water is easily drained from bottom of oil reservoir, moreover it provides an excellent protection against rust, in spite of sea water.
- This oil does not make carbonization because of its synthetic composition, keeping valves clean in spite of high temperatures. This reduces maintenance costs.
- High rate of viscosity: less viscosity rate because of temperature action.
- Multi temperature operation: stable at high temperature and fluid at low temperature.
- Well performance under pressure.
- Prevents corrosion, protects metal during its operation and intervals whether in wet or dry environments.
- Compatibility: 100% compatible with all mineral oils and most synthetic oils except siliconized oils.
- Quieter operation: notable decrease in the amount of decibels emitted by the equipment.
- Compatible with every seal: as excellent as mineral oil, this one is inert to almost every seal for a long life of these ones.
- Solvency: keeps the equipment valves and other parts which are in contact with the oil clean. It does not form sediments.
- Damping molecules: they reduce the vibration in the equipment.
- It has four times more life than mineral oils.
- Fewer oil changes means less oil purchase and less oil disposed.
- It is an environmental responsible product since it is biodegradable and it makes easy its use and adjoining.
- It does not make spume and does free air.

3.- BENEFITS

The benefits associated with this energy saving choice are having around:
$ 2,744 /month

VANE COMPRESSORS

The vane compressors consumption saving is 4% as minimum. This percentage is the base to calculate savings.

- CHICAGO COMPRESSOR #1

Rate of power needed by the compressor = 126 kW
Base functioning hours per month = 12 h/day x 31 days = 372 h.

Current consumption in base hours = (127 kW) (372 base h/funct. month) = 47,244 kWbase h/month
Consumption saving in base hours = 1,890 kWbase h/month (4%)

Total saving = (kWbase h. saved)(cost/kWbase h) + (kWbase h)(Adjustment by fuel)
Total saving = (1,890 kWbase h)(0.1584 $/kWbase h) + (1,890 kWh)(0.09409 $/kWh)
Total saving = $ 477/month

- CHICAGO COMPRESSOR #2

Since it is the same capacity as Chicago #1:
Total saving = $ 477/month

- COMPRESSOR CHICAGO #3

Rate of power needed by the compressor = 135 kW
Base functioning hours per month = 12 h/day x 31 days = 372 h.
Current consumption in base hours = (135 kW) 372 base h/funct. month) = 50,220 kWbase h/month
Consumption saving in base hours = 2,009 kWbase h/month (4%)

Total saving = (kWbase h. saved)(cost/kWbase h) + (kWbase h)(Adjustment by fuel)
Total saving = (2,009 kWbase h)(0.1584 $/kWbase h) + (2,009 kWh)(0.0949 $/kWh)
Total saving = $ 507/month

- CHICAGO COMPRESSOR #4

Rate of power needed by the compressor = 128 kW
Base functioning hours per month = 8h x 27 days + 12h x 4 days = 264h.
Pick functioning hours per month = 4h/day x 27 days = 108h.
Current consumption in base hours = (128 kW) (264base h/funct. month) = 33,792 kWbase h/month
Current consumption in pick hours = (128 kW)(108pick h/funct. month) = 13,824 kWpick h/month

Consumption saving in base hours = 1,352 kWbase h/month (4%)
Consumption saving in pick hours = 553 kWpick h/month (4%)

Total saving = (1,352 kWbase h)(0.1584 $/kWbase h) + (553 kWpick h)(0.25344 $/kWpick h) + (1,352 + 553 kWh)(0.09409 $/kWh)
Total saving = $ 533/month

Total saving in vane air compressors = compressor #1 saving + compressor #2 saving + compressor #3 saving + compressor #4 saving = $ 1,994/month

SCREW COMPRESSOR

The screw compressors saving is 4% as the minimum, and this percentage is the base to calculate savings.

- INGRESOLL RAND COMPRESSOR (steal mill area)

Rate of power needed by the compressor = 180kW
Base functioning hours per month = 8h x 27 days + 12h x 4 days = 264 h.
Pick functioning hours per month = 4h/day x 27 days = 108h.

Current consumption in base hours = (180 kW) (264base h/funct. month) = 47,520 kWbase h/month
Current consumption in pick hours = (180 kW) (108pick h/funct. month) = 19,440 kWpick h/month
Consumption saving in base hours = 1,990 kWbase h/month (4%)
Consumption saving in pick hours = 777 kWpick h/month (4%)

Total saving = (kWbase h. saved)(cost/kW) + (kWpick h. saved)(cost/kWpick h.) + (kWbase h. + kWpick h)(Adjustment by fuel)
Total saving = (1,900 kWbase h)(0.1584 $/kWbase h) + (777 kWpick h)(0.25344pick h) + (1,900 + 777 kWh)(0.09409 $/kWh)
Total saving $ 750/month

Total saving in vane and screw compressors = $ 2,744/month

Note: These numbers were given according to the consumption savings (kWh) in base hours and in pick hours and the savings of adjustment by fuel.

The saving percentage regarding F.B.M. is:
% F.B.M. = (total saving/F.B.M.) x 100
% F.B.M. = (2,744 $/month/272,597 $/month) x 100
% F.B.M. = 1%

4.- INVESTMENT COST

The investment cost was determined calculating the difference in costs, the current oil costs and the proposed cost. See table 1.

The current cots is calculated by the amount of litters in the equipment multiplied by the times in which current oil should be changed while synthetic oil lasts. The proposed cost is determined by the amount of litters in the equipment multiplied by the cost of the proposed oil (synthetic). See table 1.

Investment cost = $23,600

5.- INVESTMENT PAYBACK

Benefits will be perceived gradually as the mineral oil is substituted by the Royal Purple synthetic lubricant. See table 1 to observe the savings that would be obtained by each equipment and see where it is more convenient to start implanting this choice.

The payback period is:

Payback = investment / monthly saving
Payback = $ 23,600 * / $ 2,744
Payback = 8.6 months, which is considered a high income-yield capacity investment.
* This investment could change according to US dollar-Mexican peso exchange rate.

6.- TECHNICAL CONTEXT

There is no technical risk related to this option.

Note: The oil life can be longer if its conditions and properties do not change. Its conditions should be lab tested verifying the oil temperature and the interval of oxidation caused by contaminants. Oxidation is the sole measure of oil life.

To calculate the saving in later equipment, it is convenient to establish the current operating conditions (voltage, current, P.f., parameters) versus the future conditions when the synthetic oil is used and the real saving can be determined. In conclusion: conditions before use Vs conditions after use.

The supplier is willing to guarantee the Royal Purple synthetic oil by written.

7.- ACTION PLAN

It is proposed to make a test, measure and quantify savings to confirm the savings hereinbefore.

There are graphics available of the current electrical savings of Chicago compressors 1, 3 and 4 and the steal mill area for the Ingresoll Rand screw compressor in order to exactly obtain the saving. It is recommended to make a test of the last equipment (Ingresoll Rand compressor) since it is the one with more capacity and practically provides compressed air to the steal mill area.

Tabel 1. Savings and investments for synthetic oil in FUMOSA compressors.

Equipment	Current oil	Proposed oil	Lts./Equipment	($/litter) Current cost	($/litter) Proposed cost	Increase in working life	Current cost ($)	Proposed cost ($)	Costs difference	Energy saving ($)	Payback by month
Chicago Compressor #1 127 kW	Dte Oil Ligth 32	Synfilm 46	110	10	80	4	4,400	8,800	4,400	477	9.22
Chicago Compressor #2 127 kW	Dte Oil Ligth 32	Synfilm 46	110	10	80	4	4,400	8,800	4,400	477	9.22
Chicago Compressor #3 135 kW	Dte Oil Ligth 32	Synfilm 46	110	10	80	4	4,400	8,800	4,400	507	8.67
Chicago Compressor #4 128 kW	Dte Oil Ligth 32	Synfilm 46	110	10	80	4	4,400	8,800	4,400	533	8.25
Ingersoll Rand Compressor.- 180 kW	Dte Oil Ligth 32	Synfilm 46	150	10	80	4	6,000	12,000	6,000	750	8
								TOTALS	23,600	2,744	8.6

Energy Savings Ticket No 7
Area Thermal

NAME :

Cooling system , Arc Furnaces.

SUMMARY TABLE

Annual savings	$ 172,200 M.N.
Initial Investment	$ 302,120 M.N.
Recovering Period	21 months
Energy Savings	55.00 kW Actual demand
	8,590 kWh point
	27,800 kWh base
% Savings on basic monthly invoicing	5.3%

F.B.M. = $ 272,597 M.N.

1.0.- CONCRETE ACTION

Redesign of the present system changing to evaporative condensers, substituting the pumps and motors for high efficiency ones and redesigning also the pumping system for a closed aerator circuit.

2.0.- DESCRIPTION AND BACKGROUND

Within the capacity analysis and technical conditions made to this cooling system there were detected several severe deficiencies in the equipment and because of that relative high consumption of energy.

On the other hand, the actualization of the system requires an almost total change of equipment that if done would result in a cost almost identical to the purchase of new equipment

Also the present design has to many pumping and lacks controls that would allow the efficient operation of the system.

These items in special give us the possibility of a change in technology with very good expectations of improvement in view that a programming of a budget for maintenance of the present system is inevitable at the present so it is convenient that the expense be made in a new system thinking on efficiency parameters.

3.0.- BENEFITS

The benefits of the operation are centered in two items.

- The reduction of the electric power required by the cooling system besides enable the possibility of reducing the hours of operation, obtaining benefits both in the consumption (kWh) and the demand (kW).

The reduction on the usage of treated water as the present system uses 0.9 Gal/TR_a as it was used only the latent heat of the evaporation of the water and the proposed system uses 0.2 Gal/TR-h as this system uses besides the latent heat of the water also the sensible heat of the air.

The calculation of the benefits was as follows:

Cooling system for furnaces Whiting 1, Whiting 2, and Horno Olla.

From the analysis made of the cooling towers of the arc furnaces for the melting of iron we shall evaluate the present ticket.

Present Situation
Operation Parameters.

Water flow to the furnaces	440 G.P.M.
Thermal load of the towers	160 TR
Average temperature of the water.	35.5 °C

Energy consumption by the cooling system.

Unit	H.P.	kW real	FBM
Pump 1	20	14.06	2,871.58
Pump 2	20	13.80	2,819.50
Pump 3	25	0.0	0.00
Pump 4	40	21.54	4,399.43
Pump 5	40	20.27	4,140.54
East fan.	Not available	5.02	1,025.95
West Fan	Not Available	4.87	993.83
Tank W-1 B-1	7.5	3.44	380.53
Tank W-1 B-2	7.5	6.61	730.44
		89.61	17,361.80

Cooling rate 1.79 TR/kW
% of present capacity with respect to design 58%
Water usage by the present system..

As it is well known the way of dissipating heat in a cooling tower is based in its totality in the evaporation of water, so the cost for this resource increases somewhat he operation cost.

According the literature a system of this type requires 0.9 gallons of water to dissipate a refrigeration ton-hour, while an evaporative system requires only 0.2 gallons of water to dissipate the same amount of heat. This is true because the evaporative system uses as cooler the sensible heat of air besides the latent heat of the water.

Heat dissipated in a working day for all the system.

Thermal load of the system 160 TR .
Operation time at total load 16 h.
Approximated water usage per day 2,300 Gal. (8.7 m^3)
Monthly usage of treated water. 220 m^3
Approximated cost of treated water $ 6 pesos /m^3
Monthly Charge for water $ 1,320 M.N.

Total monthly operation cost $ 18,680 M.N.

Proposed system.

Individual cooling systems of the evaporative type with closed circuit pumping systems which shall includes a time control to actuate ON/OFF, automatically purged and deareator.

Data for the Selection

Flow of water per unit	220 GPM
Thermal Load.	100 TR

Capacity data of the cooling system and condenser.

Fan Motor	5 Hp.
Spray pump	3 Hp.
Circulating pump	10 Hp.
	18 Hp

Operating time per system, 17 hours per day from Monday to Saturday.
Monthly operating time 440 hr.

Charge for the usage of electric energy:

Electric Unit	H.P.	kW dem.	Hours/day		Charges		
			Base	Point	Dem.	Cons.	F.B.M.
Fan	5	3.73	17	Ø	22.7	416.3	439.0
Spray pump	3	2.24	17	Ø	13.6	250.0	263.6
Circulation pump	10	11.17	17	Ø	67.9	1,246.6	1,314.5
		17.14			104.2	1,912.9	2,017.1

The charge for electric energy of each system is $ 2,017.1 pesos/month, operating two equipment under similar conditions we will have a monthly charge of $ 4,034.2 pesos/month for this concept..

Water consumption with an evaporative system.

Thermal load for the system.	160 TR
Operation time at full load.	16 h
Aprox, daily usage of water	512 Gal. (1.9 m^3)
Monthly usage of treated water	50 m^3
Approximately cost of the treated water	$ 6 pesos/m^3

Monthly charge for usage of treated water $4 300 pesos.

Total monthly operation charges	$ 4,330.00
Estimated monthly savings	$14,350 M.N.

4.- Cost of the Investment.

The calculation pre estimation of the cost of the investment to put into operation this proposal is distributed in several items..

	Cost/unit	No. of Units	Cost
Evaporative condenser	13,000 USD	2	26,000 USD
Closed circuit pump	500 USD	2	1,000 USD
Change of piping and dearetor.	1,200 USD	2	2,400 USD

Control	100 USD	2	200 USD
Automatic purge	1,400 USD	2	2,800 USD
Installation and civil works	2,000 USD	2	4,000 USD
			36,400 USD

Taking an exchange rate of $8.3 pesos/ dollar

We have an initial investment of $ 302,120 pesos aprox..

5.- simple R.O.I.

= 21 month (1.8 years)

SAVINGS TICKET No. 08

AREA: SHOT BLAST AND HEAT TREATMENT.

NAME:

Cooling system, shot and heat treatment.

SUMMARY TABLE.

ANNUAL SAVINGS :	$
Monthly savings:	$
Cost of investment :	Null
R.O.I.:	IMMEDIATE
Savings in the demand:	kW
Savings in consumption:	kWhp
	kWhb
% de savings F.B.M.	%

1.- CONCRETE ACTION

Redesign and maintenance of the cooling system substituting pumps and electric motors to high efficiency ones.

2.- DESCRIPTION AND BACKGROUND

In the analysis made to the cooling system several severe anomalies were found in the design and operating conditions of the equipment..

We proceed to:

First, the present design of the piping has a inadequate distribution to be able to obtaining the maximum benefits, also it lacks a control that permits operate efficiently the system.

The conditions of the panels is poor in quantity and operation reducing the capacity of the system.

Due to the abovementioned the cooling system requires a great unavoidable investment to renew almost all the equipment to have a good operation.

3.- BENEFITS

The associated benefits with the implementation of this measure will be the reduction of the demand and consumption of electricity required by the system, due to the installation of pumps *and motors of high efficiency.*

Present situation:

The present operation parameters are:

- Flow of water to the furnaces 2,270 GPM
- Flow of water to the tower 1,130 GPM
- Thermal load of the tower in the upper part. 27°C
  lower part 20°C

Present consumption of energy for the cooling system:

Unit	HP	kW actual	F.B.M.
Pump 1	50	33.16	$ 6,773.32
Pump 2	50	31.84	$ 6,504.72
Pump 3	50	24.54	$ 5,013.44
Fan	Non available	4.93	$ 1,006.88
		94.47	**$ 19,298.36**

Cooling rate 4.12 TR/kW

Percentage of present capacity with respect to design: 78%

System Balance.

Daily thermal load.

	Cooling tower	390 TR	28.3×10^6 Kcal/day
	Shot blast (9 melts)		14.7×10^6 Kcal/day
	Heat treatment	60 TR	4.4×10^6 Kcal/day
TOTAL			**19.1×10^6 Kcal/day**

The thermal load in the cooling towers is it not enough at the beginning but in the daily operation balance it is enough and even exceeding so it is not necessary to operate them constantly..

	Load	Time
Useful load of the tower.	14.7 X 106 Kcal/day	16.2 hrs.
Extra load of the tower	9.2 X 106 Kcal/day	7.8 hrs.
Total Load	**28.3 X 106 Kcal/day**	**24 hrs.**

Thus only 70% of the operation time is useful and the rest 30% wastes the pumps.

The present proposal is to redesign the pumping system and replace the present units with new pumps of high efficiency, this to be able to control all the process with acceptable energetic goals and that the system be more efficient in operation.

The design proposed is as follows:

- A General Maintenance to the cooling tower previous a technical inspection by an specialist as to recover the original capacity taking into consideration the dimensions it should be around 500 TR.
- Change the present 15 HP motor (4.93 kw dem) by a new motor of two speeds and revise the components of the power train , gears, bars, etc., plus the fan, its physical state and attack angle.

- Change the intake of the pumps and isolate the lines as to provide only the user that requires it since today the pumps manifold supply water to the shot blast, the heat treatment area and the tower itself . ON this manner it is not possible to control the system as it does matter the requirements of cooling the system must operate at 100% load always.
- It is necessary to add that new set of pumps are required for the shot blast, the annealing area and the cooling tower as well as change of the pipes and intakes of water.
- As a final item there is the need of controls which are of extreme importance in the renovation as through them and only so we can obtain the maximum benefits.

The first contemplates the control of the cooling tower sensing the temperatures and operating the fan and pumps as needed, It is completely automatic.

The second contemplates to control the actuation of the pumps from the shot blast as to operate these only the necessary time and as a benefit the same controls a solenoid valve that should be installed in the compressed air pipe to operate this only when required.

The estimation of the capacity is as follows::

Equipment	**Load**	**Dif. of Temps.**	**Req. Flow.**	**P. Req.**
Cooling tower	500TR	10°C	670 GPM	24 psi
Shot blast	300TR	10°C	400 GPM	24 psi
Heat treatment	60TR	10°C	80 GPM	24 psi

The flow data was obtained from the following formula:

$Q = mCpDT$

Where :

$Cp = 1$ kCal / kg°C
1 TR = 3204 kCal / h
Water density = 1 kg / lto

The pressure at the outlets can be measured.

Pump Selection.

Equipment	**GPM**	**P. desc.**	**h design**	**HP**
Tower pump	670	24 psi	60	20
Shot pump	400	24 psi	60	15
Heat Treat, Pump	80	24 psi	60	30

The formula used was :

$$h = \frac{746 * GPM * CDT.psi * sg}{1714 * Power(watts)}$$

where:

GPM =Flow of water in gallons per minute.

CDT = Total dynamic load in psi

sg = Relative density, *nonadimensional* = 1

Pot. = Power required in watts

h = Efficiency

Operation factor..

Equipment	Cap.	Base	Point	F.O.	kW
Tower pump	20	20	4	0.5	14.9
Fan pump	10	20	4	0.5	7.5
Shot pump	15	3	0	1	11.2
Heat treat. pump	3	20	4	1	2.2
Total					**35.8**

kWhb	kWhp	kWht	F.B.M.
3,874	775	4,649	
1,950	390	2,340	
874	0	874	
1,144	229	1,373	
7,842	**1,394**	**9,236**	**$ 3,553**

then the monthly savings will be :

Present usage : $ 19,298

Expected usage $ 3,553

Saving $ 15,745

4.- COST OF THE INVESTMENT.

Maintenance of the tower:	$ 300,000
2 20 hp pumps	$ 60,800
2 15 hp pumps	$ 45,600
1 fan 2 speeds. 10 hp	$ 28,000
2 3 hp pumps.	$ 9,120
Labor for piping Improvements	$ 30,000
total	$ 589,040

Note: Estos precios no incluyen IVA.
Estos precios estan sujetos a cambios sín previo aviso.

5.- R.O.I.

The Return over the investment is immediate as there is no investment.,

The return simple the inversion is 5 years.
RDI= $ 589,040/ $ 118,690
RDI= 5 years aproximate

6.- TECHNICAL Context.

The implementation of all the actions and recommendations has no technical risk associated with the implementation of this energy savings measure.

7.- ACTION.

Recotización del equipo	1 week
Entrega del equipo	2 week
Instalation	2-3 week
Pruebas	1 week

SAVING CARD Nº 09

AREA: THE WHOLE PLANT

Name:

To change the electric rate from H-M to H-S.

Summary table.

Annual saving	$ 1,952,124
Monthly saving	$ 162,677
Investment cost	$ 7,000,000
Investment payback	43 months (3.58 years)
% Saving of F.B.M.	17.64%

1.- ACTUAL ACTION

- To make an agreement with C.F.E. for administrative procedures to change the rate.
- To buy a substation of 20 MVA of 110-13.8 kV, since they are essential for the contract to the H-S rate, with an electrical arrangement Delta- Estrella.

2.- DESCRIPTION AND BACKGROUND

Currently FUMOSA has a H-M rate and is looking to get a H-S one, the advantages are:

* There will be a decrease of energy cost because kWbase hour are 29.81% cheaper, the kWpick hour are 21.17% cheaper and the adjustment by fuel is about 2.33% cheaper. A little disadvantage is that the kW invoiced cost increased about 0.76% in cost, there are graphics for a better understanding of decreasing costs.

* Quality and safety in the electrical installation increase, since there are less interruptions during the year in comparison with the current rate.

* Every plant has more consumption during the base hour period, in this period of time it can be found a cost decrease.

Currently FUMOSA has lines of 110kV but because they do not have substation for this voltage, they used this lines to feed them with 13.8kV.

Some characteristics of the electrical rate are:

H-M RATE

Rate for general service in media tension, with a demand of 1,000 kW or more.

<u>Monthly minimum:</u> The resultant quantity of 10 times the charge of each kilowatt of demand that can be billed.

If the total power connected exceed from 80% to 85% any given fraction of kilowatt will be taken as a complete one.

When the user keeps for 6 months whether a Maximum Demand Measure in the pick period or a Maximum Demand Measure in the base period less than 1,000 kilowatts, he could ask for a O-M rate.

Schedule: In order to apply this rate, it will be used the national schedule, given in the decree-law from the Diario Oficial de la Federacion dated April 24, 1942.

Guarantee: Two times the money when it applies the demand cost of a contracted demand.

H-S RATE

Scheduled rate for general service in a high tension level of sub transmission.

This rate will be applied to any kind of energy used for high tension, sub transmission level.

Monthly minimum: The resultant quantity of 20 times the charge of each kilowatt of demand that can be billed.

Demand to contract: It will be given by the user; its cost won't be less than 60% of the total power connected, and it won't be less to the electric capacity of the biggest motor or the installed equipment.

If the total connected power exceeds the 60% user's substation connected capacity, the factor will be of 85%.

Any fraction kilowatt will be taken as a complete one.

Schedule: Idem to the H-M rate.

Guarantee: Idem to the H-M rate.

3.- BENEFITS

The benefits regarding energy saving are:

$ 162,677 / month

The next table shows the resulting savings when H-M is substituted by H-S.

F.B.M. saving percentage is:
% F.B.M. = (total saving / F.B.M.) x 100
% F.B.M. = (162.677 $/month / 922,066 $/month) x 100
% F.B.M. = 17.64 %

IMPORTANT: This invoice includes the whole plant since this choice will bring benefits to every plant area, having an average billing period form January to August 1996 of 922,066 $/month.

4.- INVESTMENT COST.

Investment cost was estimated in $ 7,000,000 and covers the following:

1 transformer of 12/16/20 MVA (continued functioning)
1 transformer of 8/10/12 MVA (reserve)
Protection in both sides of each transformer, control box, and electric cables.

Substation electric charts.
Administrative transactions with C.F.E.
Complete project.

If this saving choice is approved, this quotation should be updated and explain exactly the new equipment cost,. This amount is an estimate.

5.- INVESTMENT PAYBACK

Investment payback period:

Payback = investment /monthly saving
Payback = $ 7,000,000* / $162,677
Payback = 43 months (3.58 years)

* This investment is according to the US dollar-Mexican peso exchange rate.

This saving chart shows a graphic with the payback accelerating slope as time goes by. This slope is due mainly to the electricity rate increase which makes this choice more convenient; since presented investment payback time, does not consider the increases pointed out by the Diario Oficial de la Federacion.

6.- TECHNICAL CONTEXT

There is no technical risk with this choice. See graphics regarding energy savings and benefits. See graphics to appreciate the current operation and better planning ideas.

7.- ACTUAL PLAN

To define. If approved.

RATE CHANGE ANALYSIS

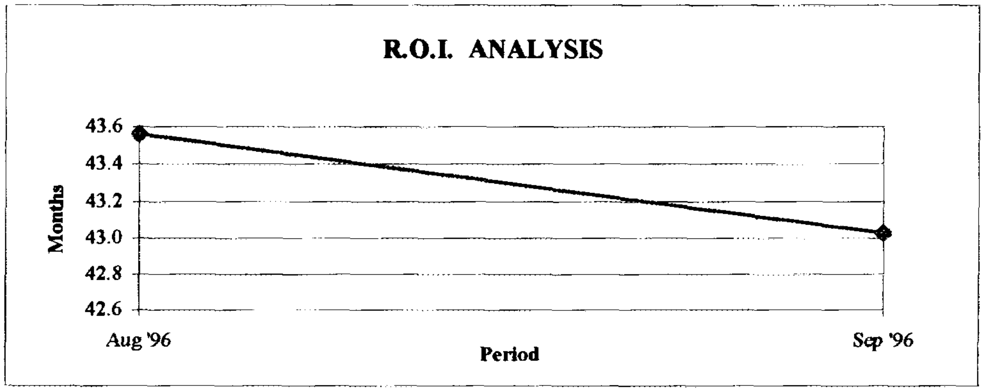
Concept	Monthly rate	Energy costs				F.B.M.				Monthly Saving	
		HM rate		HS rate		HM rate		HS rate			
		August	September	August	September	August	September	August	September	August	September
kW billed	5,558	30.401	30.766	30.634	31.002	168,968.76	170,997.43	170,263.77	172,309.12	-1,295.01	-1,311.69
Base kWh	2,986,671	0.1584	0.1603	0.11118	0.11251	473,088.69	478,763.36	332,058.08	336,030.35	141,030.60	142,733.01
Pick kWh	257,566	0.25344	0.25648	0.19977	0.20217	65,277.53	66,060.53	51,453.96	52,072.12	13,823.57	13,988.41
F.A.C.	------	0.09409	0.09539	0.09189	0.09315	305,250.26	309,467.77	298,112.94	302,200.68	7,137.32	7,267.09
Total						1,012,585.23	1,025,289.08	851,888.75	862,612.26	160,696.48	162,676.82

ENERGY COSTS FOR NORTHEAST MEXICAN AREA EN 1996

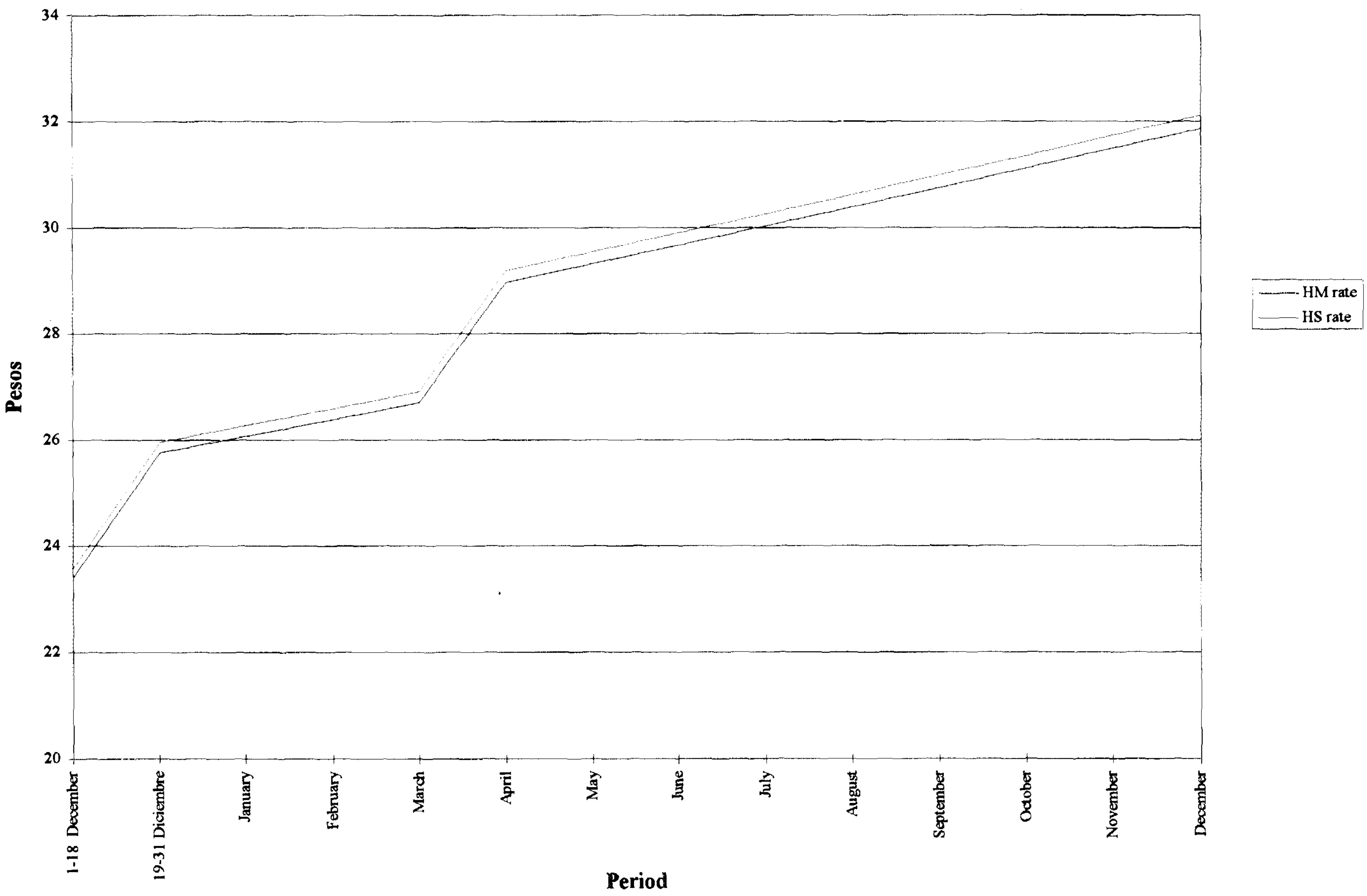
Period	kW costs billed		kWh pick cost		kWh base cost		Adjustment by fuel	
	HM rate	HS rate	HM rate	HS rate	HM rate	HS rate	HM rate	HS rate
1-18 December	23.432	23.612	0.19534	0.15397	0.12209	0.05557	0.05106	0.04986
19-31 Diciembre	25.775	25.973	0.21487	0.16937	0.13430	0.09427	0.05106	0.04986
January	26.084	26.285	0.21745	0.17140	0.13591	0.09540	0.05799	0.05663
February	26.397	26.600	0.22006	0.17346	0.13754	0.09684	0.06904	0.06778
March	26.714	26.919	0.22270	0.17554	0.13919	0.09770	0.06792	0.06633
April	28.985	29.207	0.24163	0.19046	0.15102	0.10500	0.06858	0.06697
May	29.333	29.557	0.24453	0.19275	0.15283	0.10727	0.06420	0.06779
June	29.685	29.912	0.24746	0.19506	0.15466	0.10856	0.07987	0.07800
July	30.041	30.271	0.25043	0.19740	0.15652	0.10988	0.08473	0.08275
August	30.401	30.634	0.25344	0.19977	0.15840	0.11118	0.09409	0.09189
September	30.766	31.002	0.25648	0.20217	0.16030	0.11251	0.09539	0.09315
October	31.135	31.374	0.25956	0.20460	0.16222	0.11388	-----	-----
November	31.509	31.750	0.26267	0.20706	0.16417	0.11823	-----	-----
December	31.887	32.131	0.26267	0.20954	0.16417	0.11601	-----	-----

RETURNING OF INVESTMENT

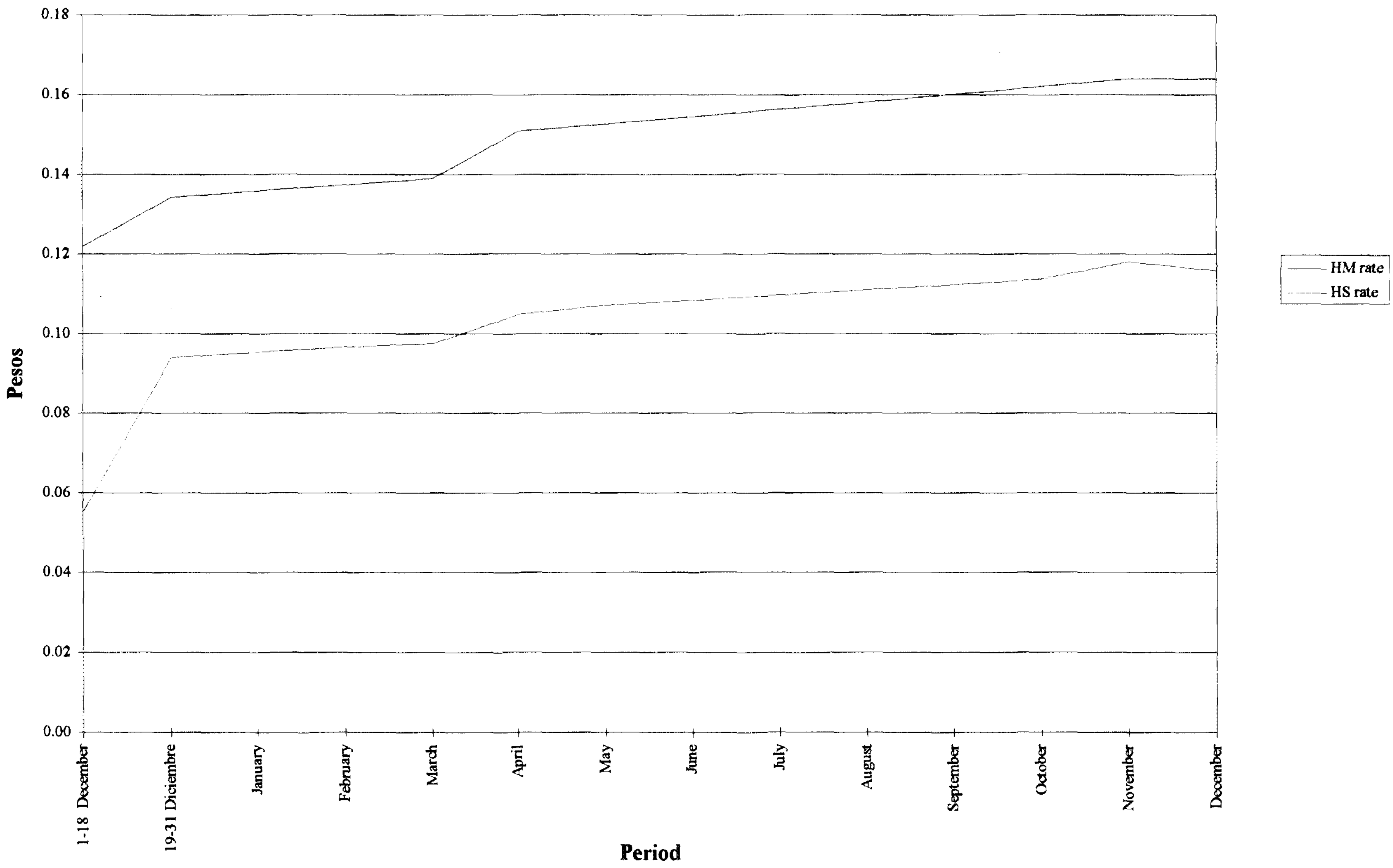
Period	Monthly Saving	Total Investment	R.O.I. months
Aug '96	160,696.48	7,000,000	43.56
Sep '96	162,676.82	7,000,000	43.03



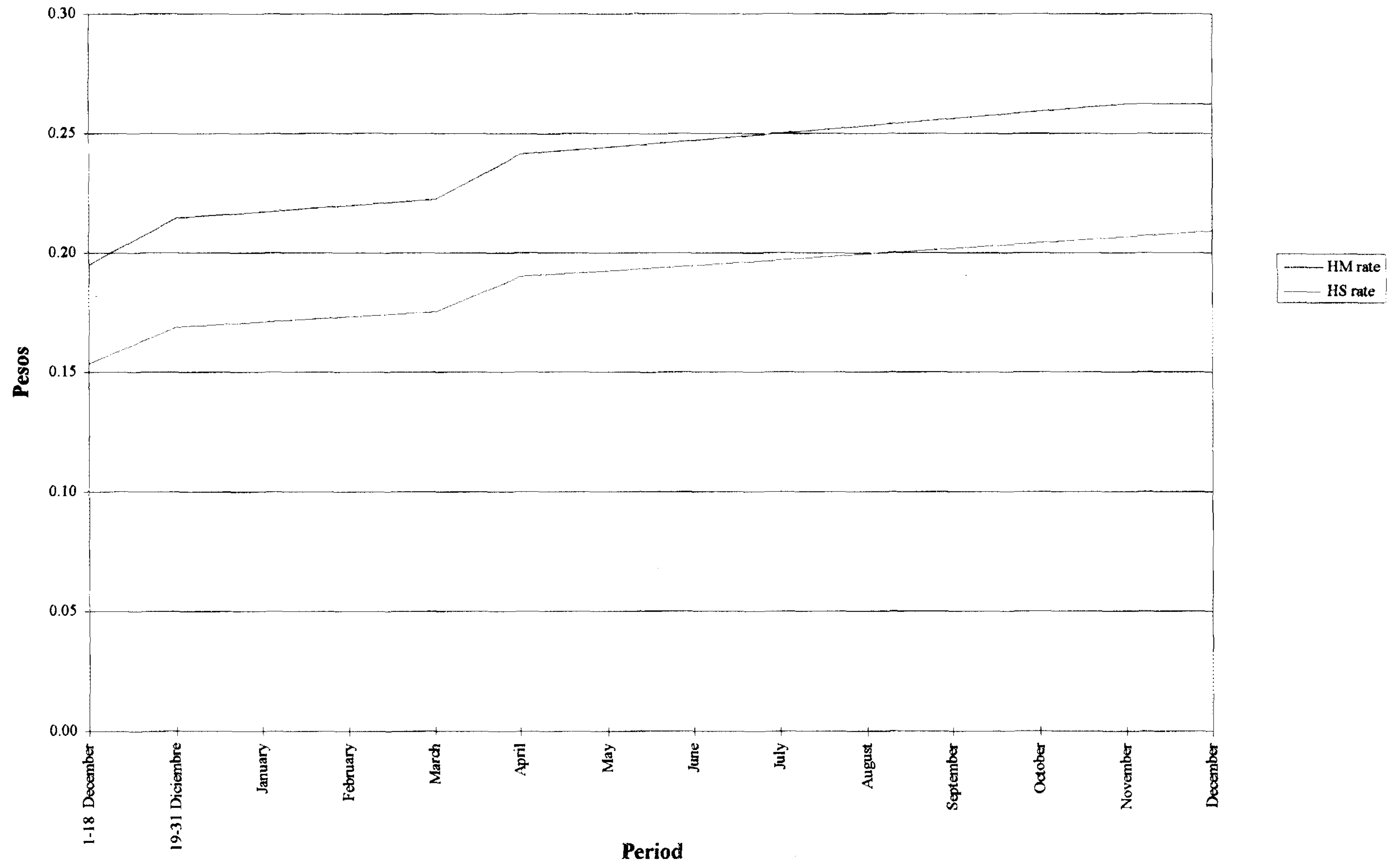
kW cost billed in 1996



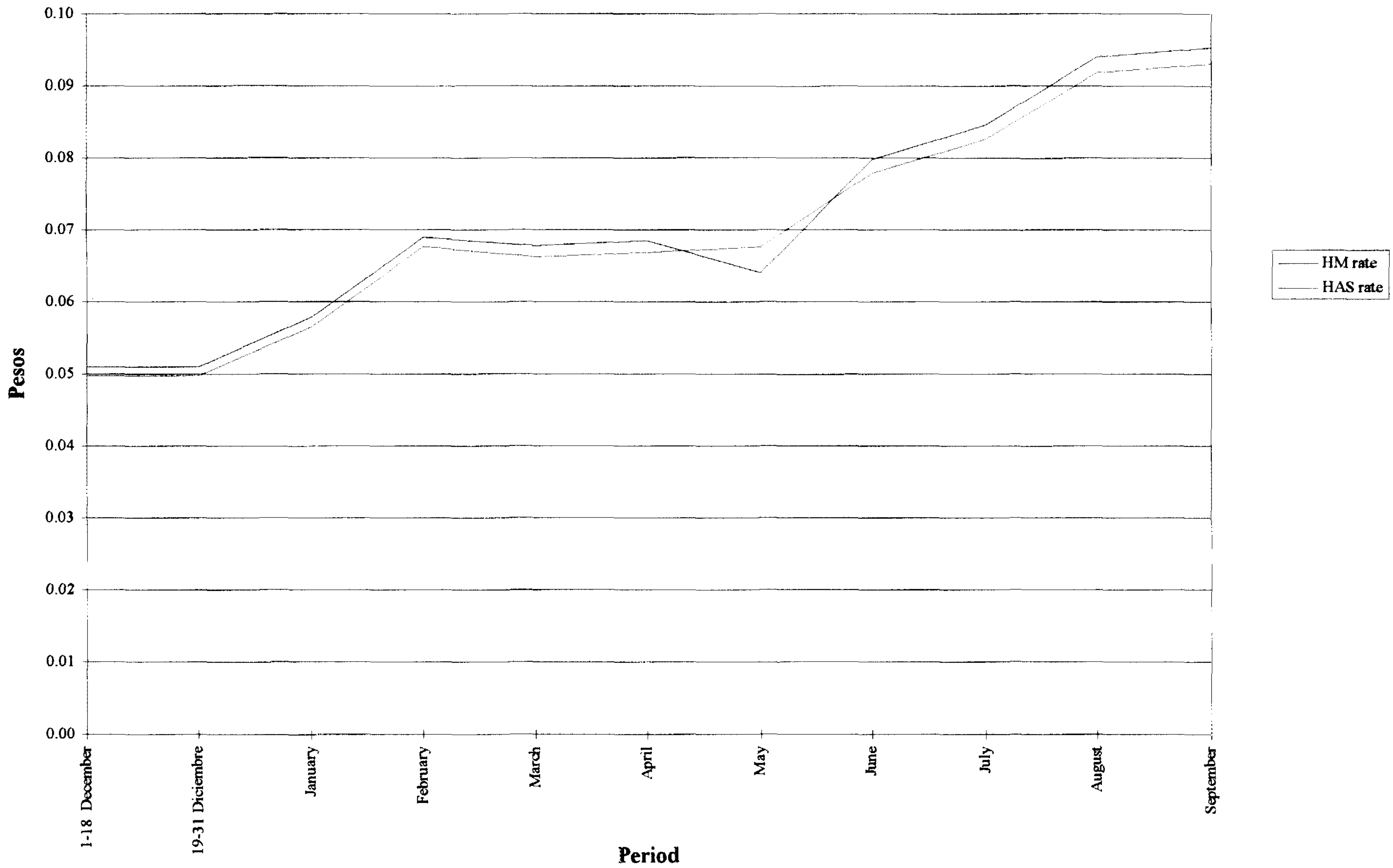
kWh Base Cost in 1996



kWh Pick Cost in 1996



Adjustment cost by fuel in 1996



SAVINGS TICKET No. 10

AREA: WHOLE PLANT

NAME:

Substitute current compressors with new high efficiency ones

SUMMARY TABLE :

Annual Savings	$ 485,168
Monthly savings	$ 40,430.
Investment cost	$ 1,274,288.
Investment return	31.44 months (2.62 years)
Savings in consumption	92,578 kWh
% F.B.M.	4.38 %

1. CONCRETE ACTION .

Substitute current compressors with high efficiency new compressors, this is done due to the inefficiency of the current compressors (54% against proposed) both because of age as their way of compressing air

2. DESCRIPTION AND BACKGROUND.

Nest we present nominal and real efficiencies for air compressor systems, and why it is convenient to replace them with high efficiency compressors

NOMINAL EFFICIENCIES FOR EACH COMPRESSOR

Comparing ft^3min/hp from new compressor vs. proposed comp. according to plate data and equivalent demanded power by equipment.

I.G. = Generation Index and its units are : ft^3min/hp.

Chicago Pneumatics compressor when new.
172.5 Hp generates 600 ft^3min a 100 psig. I.G. = 3.47 ft^3min/hp.

New Kaeser compressor proposed .
150 Hp generates 777 ft^3min a 100 psig. I.G. = 5.18 ft^3min/hp.

Capacity that current compressor would need to supply the capacity of new compressor
777 ft^3min/3.47 ft^3min/hp = 224 hp.
Power difference equivalent to saved power = 224 hp - 150 hp = 74 hp.

F.U. = Usage Factor and are the hours the equipment work per year = 0.75 = 6,570 hrs./year
1 Dollar = 8 Pesos

Energy Savings .
74 hp X .746 kW/hp X 6,570 hrs/year X 0.3071 $/kWh = $ 111,382 Pesos = 13,992 Dollars.

Taking only energy cost savings, simple return on investment would be:

Inv. return = Compressor cost 150 hp. / Savings = 54,175 Dlls. / 13,922 Dlls. = 3.89 years

REAL EFFICIENCIES FOR EACH COMPRESSOR

Comparing ft^3min./hp from current comp. # 4 vs. proposed comp. according to data from the test
Compressor - Chicago # 4 (real conditions)
172.5 hp generates 460 ft^3min. a 100 psig   I.G. = 2.66 ft^3min./hp

Compressor - Kaeser (new proposed compressor)
150 hp generates 777 ft^3min. a 100 psig.   I.G. = 5.18 ft^3min./hp

Capacity that current compressor would need to supply the capacity of new compressor
777 ft^3min. / 2.66 ft^3min./hp = 291.4 hp
Power difference equivalent to saved power = 291.4 hp. - 150 hp = 141.4 hp.

Energy savings
141.4 hp X .746 kW/hp X 6,570 hrs/year X 0.3071 $/kWh = $ 212,830 Pesos = 26,604 Dollars.

Taking only energy cost savings, simple return on investment would be:

Investment return = Compressor cost 150 hp. / Savings = 54,175 Dlls. / 26,604 Dlls. = 2.03 years

3. BENEFITS .

Benefits associated with implementation of this energy saving are e:

$ 40,430 /month

In respect to electric energy demand we conclude that:

Comp. capacity - Chicago No. 4 = 460 ft^3/min at 130 kW demand
Comp. Capacity - Kaeser = 860 ft^3/min at 130 kW demand

Chicago Compressor has a η= 76.66% in respect to plate data and in respect to Kaeser Compressor it has η = 53.5%; so we conclude that it take almost twice the energy and so twice the money to produce the same amount of air in a Chicago compressor against a Kaeser.

CONCLUSIONS:

Test conclusions for the test performed to evaluate compressor leaks in Chicago No. 4

Tank volume 1 = $\frac{3.1416 \times (1.52\ mt)^2}{4} \times 2.75\ mt = 5\ mt^3 = 176.57\ ft^3$

$1 mt^3 = 35.3146\ ft^3$

Volume of pipe going to Folasa since No. 1 tank outlet valve was not in operating conditions.

Volume 2 = $\frac{3.1416 \times (0.0508\ mt)^2}{4} \times 250\ mt = 0.5067\ mt^3 = 21.18\ ft^3$

Total Volume to fill a P= 100 lb/in^2 = 200 ft^3

$$Q = \frac{(Vol)\ (P_1 - P_2)}{(Time)\ (P.\ atm.)} = \frac{(200ft^3)(100psig)}{(3min.)(14.7\ psig)}$$ Average 460 ft^3/min.

CURRENT SITUATION
Estimating that supply flow by compressor stays at a max of 500 ft^3/min and at a demanded power of = 172.5 hp/compressor we conclude that :

Currently we need (172.5 hp.)(4 compressors .) to generate 2,000 ft.^{3}/min. at 100 psig., which gives us a total of 690 hp. to generate 2,000 ft^3/min having a generation index of :
I.G. = 2.89 ft^3/hp.

FUTURE SITUATION
What we recommend is to substitute the current system with a system as follows :
1 200 hp. Kaeser compressor, model ES290 with a 1,054 ft^3/min. capacity at 100 psig. and 2 100 hp. Kaeser compressors, model DS140 with a 543 ft^3/min. capacity at 100 psig. each.

With this system we would have a 400 hp. demand to generate 2,140 ft^3/min. having a generating index of : I.G. = 5.35 ft^3/hp.

F.U. = Usage Factor and are the hours the equipment work per year = 0.5 = 4,380 hrs./year
1 Dollar = 8 Pesos

Savings calculation :

Savings # 1 = Savings by total generation
Savings # 1 =(power difference)(kW/hp.)(cost$/kWh.)(F.U. = 0.5)
Savings # 1 = (290hp.)(0.746)(0.3071)(4,380) = 290,998 Pesos/year = 36,375 Dollars/year

Savings # 2 = Savings per extra generating capacity
Current equipment generates 2,000 ft^3/min. with 690 hp. y its I.G. = 2.89 ft^3/hp.
Future equipment generates 2,140 ft^3/min. with 400 hp. y its I.G. = 5.35 ft^3/hp.
Savings # 2 = 2,140 ft^3/min./ 2.89 ft^3/hp. = 740 hp., concluding : 740 hp. will be required to generate 2,140 ft^3/min. with the kind of compressor currently installed, so we have an additional savings of 740 hp. - 690 hp. = 50 hp.
Savings # 2 = (50 hp.)(0.746)(0.3071)(4,380) = 50,172 Pesos = 6,271 Dollars.

Savings # 3 = Savings for maintenance estimating a 3,000 pesos monthly cost per compressor.
Savings # 3 = (3,000$/mes)(12 month)(4 compressors) = 144,000 Pesos = 18,000 Dollars

Total Annual Savings = Savings # 1 + Savings # 2 + Savings # 3 = 485,168 Pesos = 60,646 Dollars

Monthly Savings = $ 40,430

Saving percentage in respect to F.B.M. is:

% F.B.M. = (total Savings / F.B.M.) × 100
% F.B.M. = (40,430 $/month / 922,066 $/ month) × 100
% F.B.M. = 4.38 %

Important Note : Billing used in this saving ticket as reference is for the whole plant since this measure will bring benefits to all areas, it will have an average bill for January-August '96 de $922,066/ month.

4. INVESTMENT COST.

Investment cost is 159,286 Dollars equivalent to 1,274,288 Pesos

Requiring 1 200 hp. compressor and 2 100 hp. compressors

1 200 hp. Kaeser compressor - model. ES290 with 1,054 ft^3/min. capacity at 100 psig.
has a cost of 73,042 Dollars
1 100 hp. Kaeser compressor - model DS140 with 543 ft^3/min. capacity at 100 psig.
has a cost of 43,122 Dollars

This quote is subject to chance according to exchange rate (peso against dollar). For this ticker calculation we used 8 pesos per dollar

5. INVESTMENT RETURN .

The simple return on investment period (payback) is:

Payback = investment / monthly savings
Payback = $ 1,274,288* / $ 40,430
Payback = 31.44 months (2.62 years).

* This investment can change accordingly with the exchange rate.

As can be observed, payback time is very attractive even if it is an expensive equipment. due to their high efficiency. Cost for these equipment ranges 20% higher against other more commercial brands, we should also point out that maintenance cost will drop also by 50%.

Next we show a relationship between same capacity compressor brands to compare against Kaeser and get the savings from this one, as well as return on investment

F.U. = Usage Factor and are the hours the equipment work per year = 0.5 = 4,380 hrs./year
1 Dollar = 8 Pesos

Savings calculation :

Savings # 1 = Total generation Savings
Savings # 1 =(power difference)(kW/hp.)(cost$/kWh.)(F.U. = 0.913)

Savings # 2 = Package nominal capacity savings.
Savings # 2 =(power difference)(kW/hp.)(cost$/kWh.)(F.U. = 0.913)

ATLAS VS KAESER VS INGERSOLL RAND 200 HP. COMPRESSOR COMPARISON

Kaeser model ES290, generates 1,054 ft^3min. at 100 psig. with I.G. = 5.27 ft^3min. / hp demanding 149 kW
Atlas model GA160, generates 981 ft^3min. at 100 psig. with I.G. = 4.91 ft^3min. / hp. demanding 160 kW in the whole package.
Capacity that Atlas compressor would need to supply the capacity of Kaeser proposed.
1,054 ft^3min. / 4.91 ft^3min./hp = 214.66 hp
Difference in power equivalent to power saved = 214.66 hp. - 200 hp = 14.66 hp.
Savings # 1 = (14.66hp.)(0.746)(0.3071)(8,000) = 26,868 Pesos/year = 3,358 Dollars/year

Savings # 2 =(11)(0.3071)(8,000) = 27,025 Pesos/year= 3,378 Dollars/year

Savings obtained between a Kaeser and a Atlas 200 hp. compressor = Savings # 1 + Savings # 2 = 6,736 Dollars.

Ingersoll Rand compressor - model SSR XF200, generates 993 ft^3 at 100 psig. with I.G. = 4.97 ft^3min. / hp. demanding 220 hp. in the whole package.
Capacity that Ingersoll Rand compressor would need to supply the capacity of the Kaeser.
1,054 ft^3min. / 4.97 ft^3min./hp = 212.07 hp
Difference in power equivalent to power saved = 212.07 hp. - 200 hp = 12.07 hp.
Savings # 1 = (12.07hp.)(0.746)(0.3071)(8,000) = 22,121 Pesos/year = 2,765 Dollars/año

Savings # 2 =(20)(0.746)(0.3071)(8,000) = 36,655 Pesos/year = 4,582 Dollars/año

Savings obtained between a Kaeser and an Ingersoll Rand 200 hp. compressor = Savings # 1 + Savings # 2 = 7,347 Dollars.

COMPARISON BETWEEN ATLAS VS KAESER VS INGERSOLL RAND 100 HP COMPRESSORS

Kaeser model DS140, generates 543 ft^3min. at 100 psig. and 486 ft^3min. at 125 psig. with I.G. = 5.43 ft^3min. / hp at 100 psig. and 3.88 ft^3min. / hp at 125 psig. demanding 75 kW
Atlas model GA75-100, generates 487 ft^3min at 100 psig. with I.G. = 4.87 ft^3min. / hp. demanding 82 kW in the whole package.
Capacity that Atlas compressor would need to supply as proposed Kaeser.
543 ft^3min. / 4.87 ft^3min./hp = 111.5 hp
Difference in power equivalent to power saved = 111.5 hp. - 100 hp = 11.5 hp.
Savings # 1 = (11.5hp.)(0.746)(0.3071)(8,000) = 21,077 Pesos/year = 2,635 Dollars/año

Savings # 2 =(7)(0.3071)(8,000) = 17,198 Pesos/year = 2,150 Dollars/año

Saving between a Kaeser and an Atlas 100 hp. compressor = Savings # 1 + Savings # 2 = 4,785 Dollars.

Ingersoll Rand model SSR EP100, generates 446 ft^3/min. at 125 psig. with I.G. = 3.56 ft^3min. / hp. demanding 110 hp. in the whole package .
Capacity that Ingersool Rand compressor would need to supply as proposed Kaeser.
486 ft^3min. / 3.56 ft^3min./hp = 136.51 hp
Difference in power equivalent to power saved = 136.51 hp. - 100 hp = 36.51 hp.
Savings # 1 = (36.51hp.)(0.746)(0.3071)(8,000) = 66,914 Pesos/year = 8,364 Dollars/año

Savings # 2 =(10)(0.746)(0.3071)(8,000) = 18,327 Pesos/year = 2,291 Dollars/año

Savings between a Kaeser and a Ingersoll Rand 100 hp. compressor = Savings # 1 + Savings # 2 = 10,655 Dollars.

6. TECHNICAL CONTEXT.

There is no technical risk associated with the implementation of this measure.

It needs to be mentioned that integrating these compressors to the plant the whole compressed air system will be renovated since you will be buying new high efficiency compressors. The compressors currently installed are very inefficient due to their design. They supply air but at a very high conditions in temperature, energy and maintenance.

It is *important to mention that with Kaeser compressors we still have 15% capacity* ft^3/min. and a +/- 15% in electric power, since the pulley diameter can be changed at the compressor unit (screw) and this was not considered in the above calculations, also this modification in case of being required would be easy because the coupling is with belts.

It is important to take into account the improvements in 3.1.4.4 for a more efficient use of compressed air.

7. ACTION PLAN .

To be defined. Subject to approval, if buying compressors, preferably get the 2 100 hp compressors first to have a better demand control.

SAVING TICKET No. 11

AREA: STEEL

NAME :

Rehabilitation of charge control valve in Ingersoll Rand compressor .

SUMMARY TABLE :

Annual Savings	$ 45,000
Monthly savings I	$ 3,750
Investment cost	$ 5,000
Investment return	1.33 months
Demand savings	0 kW
Savings consumo	13,385 kWh
% F.B.M.	1.37 %

1. CONCRETE ACTION .

Rebuild charge control valve in Ingersoll Rand compressor since its behavior is very unstable due to the conditions of its control system

2. DESCRIPTION AND BACKGROUND.

This compressor has been recently bought by the company to satisfy mainly the sand recycling hoppers since consumption in considerable and the current system without the Ingersoll Rand compressor cant keep the system's pressure. As we checked, this compressor is working correctly in its compressing unit but was not modulating according to load having a very variable draw, It was kicking in and out constantly at a 5 to 1 ration (8 seconds charging and 2 seconds discharging) producing very high power peaks (full load) and constantly. What we propose is to rebuild the control system to get a smother operation and obtain energy savings due to a better operation.

3. BENEFITS .

Benefits associated with the implementation of this savings measure are

$ 3,750 /month

SCREW COMPRESSOR

Estimating 12 hours of constant operation a day for the whole month.
The savings in energy consumption due to this fault and behavior can be considered around 20% of current consumption since in the average we can consider Thai 5 to 1 ratio, this being the base percentage for savings calculation.

- **Ingersoll Rand compressor (steel area).**

Power demanded in average by compressor = 180 kW
Total Monthly base operating hours = 8 hrs. x 27 days + 12 hrs. x 4 days = 264 hrs.
Total Monthly peak operating hours = 4 hrs./day x 27 days = 108 hrs.
Current base hour consumption = (180 kW) (264 hrs. base/month of oper.) = 47,520 kWh base/month
Current Peak hour consumption = (180 kW) (108 hrs. peak/month of oper.) = 19,440 kWh peak/month

Savings in base consumption = 9,500 kWh base/mes (20%)
Savings in peak consumption = 3,885 kWh peak/mes (20%)

Total savings=(kWh base saved)(cost/kWh base) + (kWh peak saved)(cost/kWh peak) + (kWh base + kWh peak)(Fuel Adjustment)
Total savings = (9,500 kWhb)(0.1584 $/kWhb) + (3,885 kWhp)(0.25344 $/kWhp) + (9,500 + 3,885 kWh)(0.09409 $/kWh)
Total savings = $ 3,750/month

Note: In these calculation we took into account consumption savings (kWh) in base, peak and fuel adjustment

Savings percentage against Monthly Basic Bill is :

% F.B.M. = (Total savings / F.B.M.) ×100
% F.B.M. = (3,750 $/month / 272,597 $/month) × 100
% F.B.M. = 1.37 %

4. INVESTMENT COST .

Cost of investment is estimated to be 5,000 Pesos either by specialized personnel or plant maintenance personnel

5. RETURN ON INVESTMENT.

The benefits associated with the implementation of this saving measure will be received according to the way this readjustment is made in the capacity valve or the charge control system

Simple period for investment return (payback) is :
Payback = investment/ monthly savings
Payback = $ 5,000 / $ 3,750
Payback = 1.33 months , for which this is considered a highly profitable investment.

6. TECHNICAL CONTEXT .

There is no technical risk associated with the implementation of this savings measure

7. ACTION PLAN .

We have a current electric behavior chart for the Ingersoll Rand screw compressor in the steel area to obtain exact savings, or at least us it as current operation base, we recommend fixing this control as soon as possible.

Savings Ticket No 12
Thermal Area

Name:

Efficiency loss correction in thermal treatment furnaces.

SUMMARY TABLE

Savings in annual cost	$ 357,000 M.N.
Initial investment	$ 850,000 M.N.
Recovery period	30 months
Energy Savings	46,700 Nm^3 de Gas Natural
% Savings in Monthly bills	40%

Natural Gas F.B.M. = $ 74,600 M.N.

1.0.- CONCRETE ACTION

Update of combustion system that operates the tempering furnaces reducing to the maximum the losses through sensitive smoke and incomplete combustion, this is achieved with the installation of heat recovery system in exhaust gases, special low NOx burners and periodic tune-up according to energy acceptable parameters

2.0.- DESCRIPTION AND BACKGROUND

According to gas analysis performed in the thermal treatment furnace exhausts gas we detected several deficiencies against a good combustion.

If we observe the chart that shows the operation parameters for thermal treatment furnace we can se that all of them show a more or less degree of loss by some concept, furnace No. 2 operating with the highest energy cost.

For the tempering furnaces their biggest problem is the high exhaust temperatures at which smoke goes out, taking with it important energy as sensitive heat.

For Annealing furnaces the main problem can be seen to be the high percentage of excess air in which it operates, they also present important energy losses as sensitive heat in exhaust gas, due to the great amount of air being handled.

3.0.- BENEFITS

Benefits were obtained performing respective balances in each consuming equipment, once all aspects evaluated as to losses based on operation features for each one, we proceeded to compare them relative to efficient and acceptable combustion which presents corrected combustion parameters

Then we proceeded to evaluate savings in monthly cost for each one based on monthly operation hours

Parámetros de Operación en los Hornos de Tratamiento Térmico.

Parámetro	Templado 1	Templado 2	Templado 3	Revenido 1	Revenido 2
O_2, %V	9.3	8.4	2.7	13.4	18.5
CO_2, %V	6.3	6.9	9.6	4.2	1.3
CO, ppm	115	40	175	0	786
Datos medidos y calculados a condiciones reales					
Temp, °C	470	640	806	416	240
% exc.aire	82	64.4	22.7	167	510.7
% ef, P.C.I.	75	67.4	68.1	68.8	42.6
Costo, $/hr	29.48	32.82	32.48	21.42	34.62
Datos estandares de máxima eficiencia					
Temp, °C	180	180	180	180	180
% exc.aire	9.6	9.6	9.6	9.6	9.6
% ef, P.C.I.	94.7	94.7	94.7	94.7	94.7
Costo, $/hr	23.36	23.36	23.36	15.58	15.58
Beneficios esperados por corrección de deficiencias					
Operación,h/mes	620	620	620	580	580
Ahorro, $/mes	3,794	5,865	5,654	3,387	11,043

Ahorro total, $/mes 29,744

For this reason we can expect monthly savings by correcting these factors of about :
Natural Gas Consumption Savings 46,700 Nm3
Economic Savings 29,744 M.N.

4.- INVESTMENT COST .

Initial investment calculation to start this proposal is distributed in several parts

Complete low NOx burners (5 units)	13,000 USD
Heat recovery for combustion air (5 units)	5,000 USD
Engineering and installation	12,000 USD
Total investment cost	102,000 USD

Considering an exchange rate of $ 8.3 pesos M.N./USD.
We have an initial investment of $ 850,000 pesos M.N. aprox..

5.- SIMPLE INVESTMENT RETURN.

$$= \frac{\$\ 850{,}000\ \text{M.N.}}{\$\ 29{,}744\ \text{mn/month}} = 30\ \text{months (2.5 years)}$$

6.- TECHNICAL CONTEXT .

Application of this measure in very important since once these systems are updated we will be using resources more efficiently.

It is necessary to point out that a periodic tune-up is required in these equipment and that in the mean time a tune-up for current equipment can be made, this will reduce looses but will not be a definitive measure.

6.- STUDIES PERFORMED IN THE INDUSTRIAL ENGINEERING AREA

6.1 IDEAS AD IMPROVEMENT SYSTEM EN-3.

As part of the programmed activities within the **Energy Saving Program,** relative to interaction, participation and involvement of plant personnel, mainly in the quality and productivity areas, we pretend to impart the EN-3 system for ideas and improvement.

¿ What is EN-3 ?

EN-3 is a tridimentional matrix system which allows us to relate the degree of affectation and ponderization between Energy, Ecology, and Quality and productivity parameters.

The system's application process is divided in three work sessions, aprox. one hour long each.

In the first session, assigned teams give the most number of possible ideas in Energy, Ecology, and Quality and productivity parameters, (storm of ideas).

With the list of ideas, these are separated according to parameter and integrated into the ponderation matrix, (fig. 1).

During the course of the second session, designate the degree of ponderization (strong, medium, weak) based on a consensus among the departments.

Finally these data is processes and evaluated to separate critical and vital variables of the system (fig. 2).

A critical variable will be that which based on the ponderizing it got, affects 2 or more parameters and a high score.

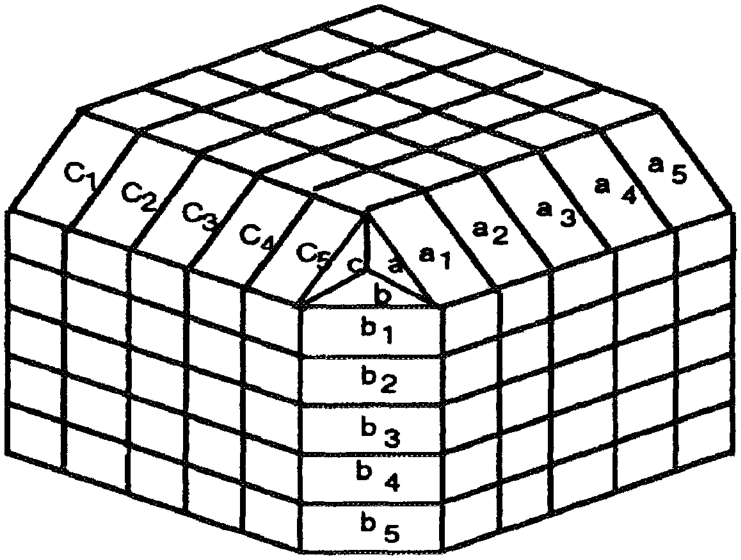
A vital variable will be that in which the affecting value is of medium range or only affects 1 or 2 parameters.

Needs to be said that for a better result in applying the system you must have active participation of the work group(s), made up by the different departments at Fundicion Monclova S.A de C.V. such as : Production, electric and mechanical maintenance, Management, Human Resources, and others.

EL SISTEMA GRAFICO DE ANALISIS
LA MATRIZ TRIDIMENSIONAL TIPO " Y "
Y EL ESPECTRO DE PONDERACION

EN3
(ECOLOGIA)

EN2
(ENERGIA)



EN1
(CALIDAD Y PRODUCTIVIDAD)

RELACION FUERTE (9)

RELACION MEDIA (3)

RELACION DEBIL (1)

FIG. 1

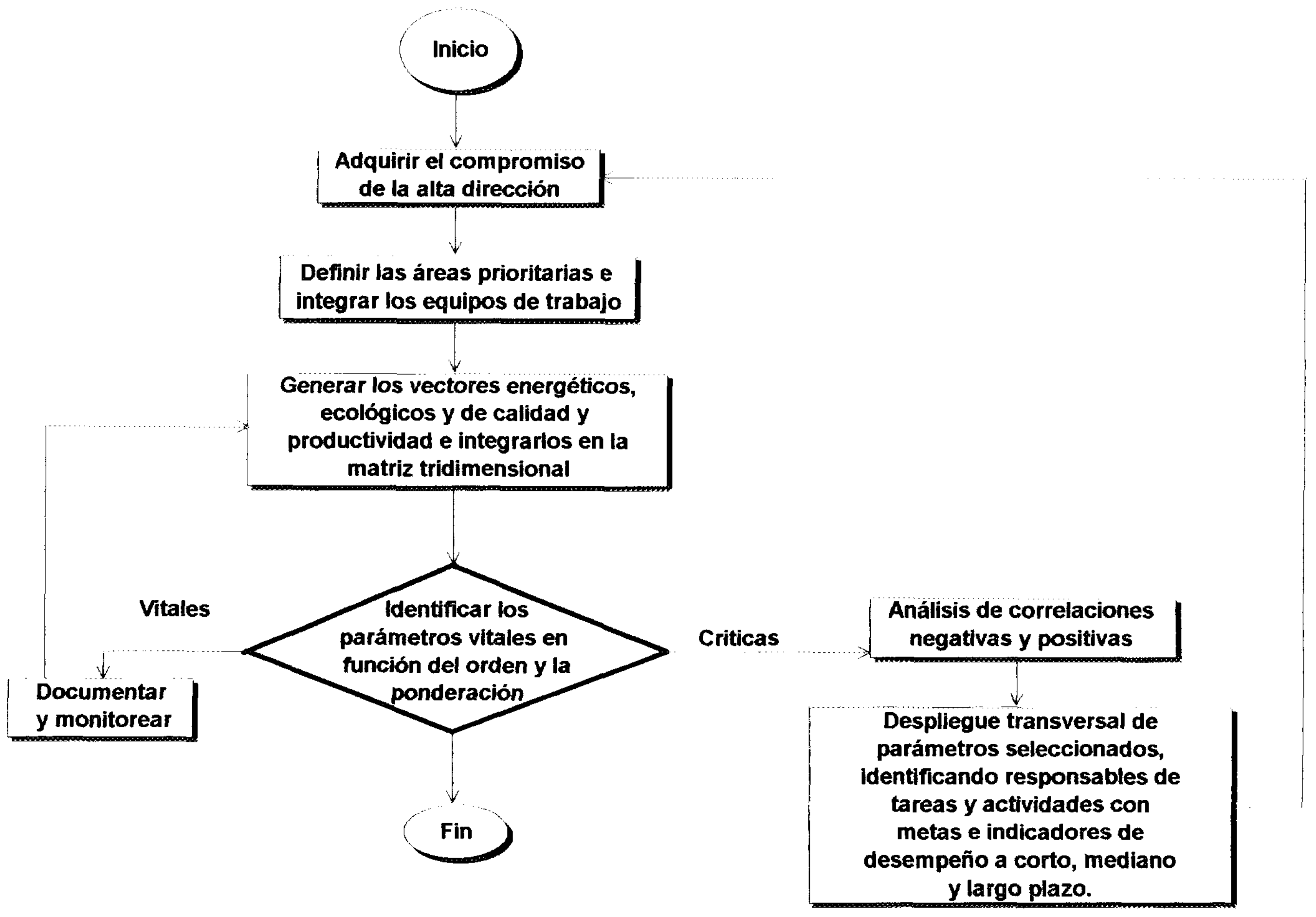

Inicio
Adquirir el compromiso de la alta dirección
Definir las áreas prioritarias e integrar los equipos de trabajo
Generar los vectores energéticos, ecológicos y de calidad y productividad e integrarlos en la matriz tridimensional
Identificar los parámetros vitales en función del orden y la ponderación
Vitales
Documentar y monitorear
Criticas
Análisis de correlaciones negativas y positivas
Despliegue transversal de parámetros seleccionados, identificando responsables de tareas y actividades con metas e indicadores de desempeño a corto, mediano y largo plazo.
Fin

FIG. 2

SUMMARY OF IDEAS AND IMPROVEMENT SYSTEM IN EN-3

GROUP 1:

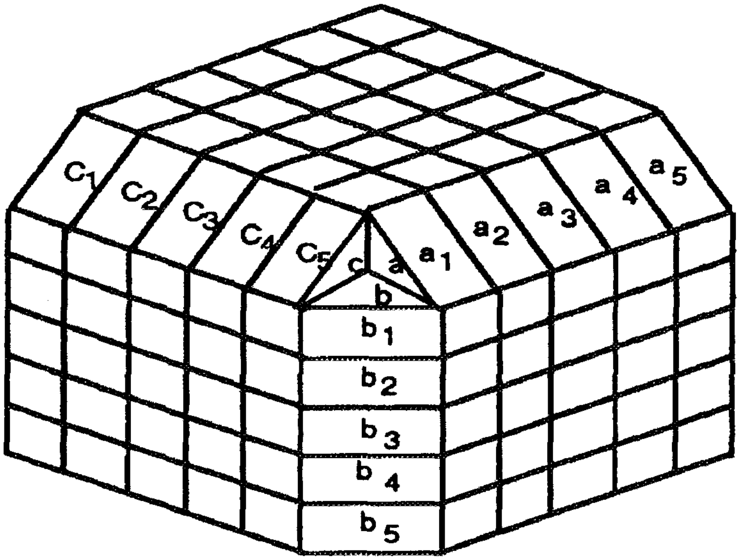
IDEAS ON ECOLOGY	12
QUALITY AND PRODUCTIVITY IDEAS	20
ECOLOGY IDEAS	18
TOTAL	**50**

As per activities cronogram for the energy saving project performed by the consulting company's work group, the ideas and improvement system EN3 was given at the quality laboratory meeting room, and received a very favorable response by the personnel designated by **Fundición Monclova S.A. de C.V.** *in attendance and active involvement, with the energy savings committee* (CADE) being responsible to do all follow-ups on each idea generated.

The results of this group are presented in the following pages, separated into Critical Variables and Vital Variables.

It needs to be mentioned that the critical variables have, in their presentation tables, a brief description of the idea as well as the responsible for follow up and implementation of each idea.

Last, we recommend that CADE periodically performs similar EN3 systems that will allow personnel active participation to generate ideas and improvement areas in the plant.



FUNDICION MONCLOVA, S.A. DE C.V.
VARIABLES VITALES
ENERGIA

* Sellado adecuado de la bóveda y puerta de los hornos W-1 y W-2. (uniones)

* Capacitación y adiestramiento en el manejo de los electrodos.

* Agilizar el procedimiento de análisis de la muestra.

* Apagar los focos de las oficinas y naves de producción cuando no se necesiten.

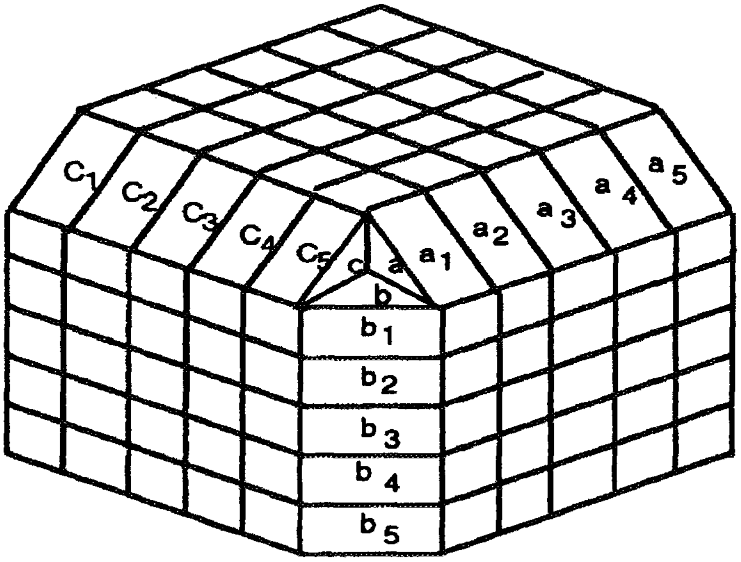
* Alternar la operación de los hornos, para evitar demoras y disminuir la demanda.

* Mejorar el factor de carga de los hornos en general.

* Rehabilitar el techo de las naves y de los edificios con láminas translúcidas, para aprovechar la luz natural al máximo.

* Establecer etapas de fusión (tap´s) y de las temperaturas de trabajo.

* Checar que el arco de los hornos sea el ideal, para la fusión.



FUNDICION MONCLOVA, S.A. DE C.V.
VARIABLES VITALES
CALIDAD Y PRODUCTIVIDAD

* Cambiar anillos de bóvedas, están en malas condiciones.

* Tener el servicio del almacén los tres turnos.

* Instalar una línea de emergencia de aire comprimido, para el horno W-2.

* Tener un sistema de enfriamiento adecuado para los hornos.

* Mantenimiento del sistema hidraúlico de los hornos.

* Tener cuidado, para dar el peso de las ferroaleaciones.

* Muchas fallas en el sistema de nivelación del horno W-2.

* Cortar la chatarra en medidas más chicas.

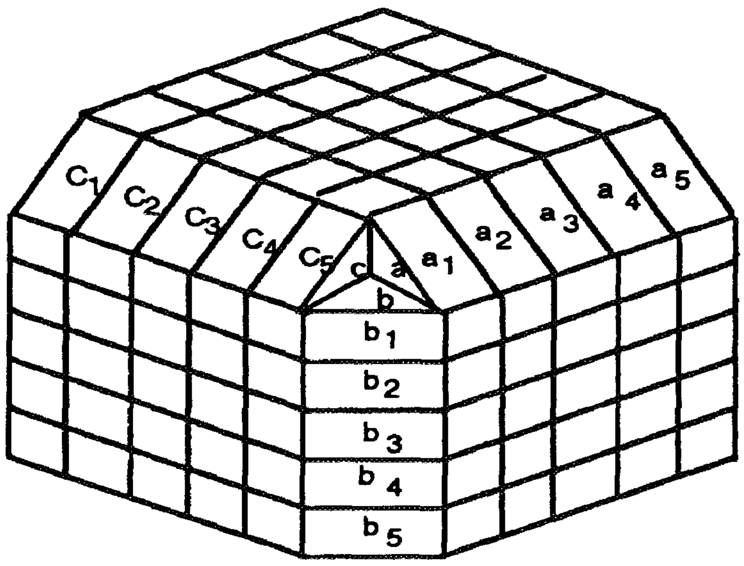
* Tener siempre en condiciones optimas de operación el horno-olla y la estación de vacío.

* Tener lainas ya preparadas por mantenimiento, para el apriete de electrodos en brazos.

* Mejorar el sistema de alimentación de oxígeno en los hornos.

* Contar con un programa de producción, para tener la materia prima necesaria para dicho programa.

* Checar mangueras y conexiones, para evitar fugas de aire, agua, aceite, etc.



FUNDICION MONCLOVA, S.A. DE C.V.
VARIABLES VITALES
MEDIO AMBIENTE Y ECOLOGIA

* Evitar al máximo la contaminación del medio ambiente.

* Instalar un sistema de recirculación de gases.

* Checar los extractores de aire que se tienen actualmente

FUNDICION MONCLOVA
CRITICAL AREAS

No.	CONCEPT	DESCRIPTION	RESPONSIBLE
ENE.1	Junk preheating	Verify the practicability to preheating junk, to reduce melt and enery consuption	CADE
ENE.2	To improve electrical controls of the Withing 1 y 2 hydro arc furnace	To make maintenance programs to this controls or changes if necessary	"
ENE.3	Proper use and sealed leaks of compressed air	To establish permanent programs in every area in order to detecto and eliminate air leaks, water leaks, and oil leaks, etc.	"
ENE.4	Reducing time between one melt and another	Detectar el tipo de demoras que ocasiona que el tiempo entre una	"
ENE.5	To verify energy consumption per melt (kWh/ton)	To make a report about the energy consumption regarding each melt in order to detect the changes in the process.	"
ENE.6	Tur on the pumping system when it is not necessary	To stablish the best operating option of this system in order to avoid energy and water consumption	"
ENE.7	To feed ovens with dense iron scoria	Currently, because of the oven's charge, it is necessary to make recharges and it delays the melt	"
ENE.8	To make physical and chemical analysis of the raw material about the % of iron and its oxides	Nowdays, there isn't any kind of analysis which inform the percentage of iron, oxids, silicate, etc. that the material has.	"

FUNDICION MONCLOVA
CRITICAL AREAS

No.	CONCEPT	DESCRIPTION	RESPONSIBLE
CYP.1	Staff training about the optimum functioning of the hydro arc furnace	Develop training programs to allow personnel to know the functioning of the equipment and its tasks in a more efficient way	CADE
CYP.2	Identification of the kinds of junk depending on the product to be ellaborated	With this, changing the ovens will be easily making the use of them more efficient (less delays)	"
CYP.3	More efficient communication and less time of response with maintenance department staff	Some times maintenance response department cause delay in the process	"
CYP.4	Follow up production and wash vestiments consistently	Carry out programs for no internal delay as well as no external delay in the process	"
CYP.5	Cut the junk in smaller peaces to feed the ovens	Currently, there is no control over the size of the pieces feeding the oven and this cause delay in the process	"
CYP.6	Verify there is no lack of material and/or tools to operate orvens	Before beginning each operating shift, make sure there are available all the necessary tools, junk, personnel, etc.	"
CYP.7	Clasify junk by density and chemical analysis	Currently there is no control over the kind of junk nor over its chemical composition (% iron)	"
CYP.8	Improve preventive maintenance system for ovens	Establish preventive maintenance programs according to the needs of production, efficiency, time of respones)	"

FUNDICION MONCLOVA
CRITICAL AREAS

No.	CONCEPT	DESCRIPTION	RESPONSIBLE
MED.1	Organize, clean and keep in good appearance working areas	Establish ecological programs, cleaning, 5's, etc. in every area	CADE
MED.2	Avoid environmental pollution	Follow up ecological parameters, gas analysis, etc.	"
MED.3	Keep the oven vaults clean, so they can fit well and do not smoke a lot	Give maintenance to the oven vaults to avoid exececssive smoke, etc.	"
MED.4	Use appropiate safety equipment	Provide the appropiate safety equipment for each operation and make conscius of the importance of its use	"
MED.5	Improve and make it more efficient to extract smoke and dust of ovens area	Currently these systems do not make their work efficiently (extract smoke from ovens) polluting the working area	"
MED.6	Verify if it is possible to take advange of the latent smoke heat to heat the junk	Check the possibility to carry out this operation to take advantage of the heat and save power energy	"

6.2 ENERGY SAVING COMMITTEE.

Background.

The importance of the measures and recommendations presents in this Diagnosis creates the need to form an Energy Saving Committee **(CADE)**, that will perform the function monitoring and auditor functions, in order to keep the energy saving culture alive at the plant and also, guarantee the advantages of the potential energy saving detected. We should mention the grate interest shown by Fundición Monclova, S.A. de C.V. as to the energy Saving Program being carried out in the steel area, to coordinate activities, actions and measures for electric energy and fuels.

The personnel that will be part of the committee is shown on **Chart 1,** where the main activities they shall perform as members of **CADE** are also shown.

Goal .

For CADE, the main goal proposed is to use the methodology applied by the consulting firm, to detect energy saving opportunity areas, on order to achieve the optimal energy usage, follow-up and apply all measures and recommendation emitted during the Program, with the intention of getting the most benefit from these and to keep permanent the energy saving culture at **Fundición Monclova S.A. de C.V.**

Advantages.

The main advantages of institutionalizing a committee of this kind are summed up as follows:

a) Give energy a key roll in a global competitiveness and production cost reduction strategy for the company.

b) Promote saving and efficient use of energy in all areas of the company, in an institutional and permanent form.

c) Obtain agreements on the energy conservation projects presented in the Diagnosis, and that could affect one or several areas in the company.

d) Give a stronger foundation for those recommendations coming from the committee

e) Jointly analyze the problems presents in different areas and generate recommendations to promote saving and better use of energy.

CUADRO 1
COMITE DE AHORRO DE ENERGIA

INTEGRANTES	RESPONSABLES	PRINCIPALES ACTIVIDADES
LIDER DEL PROYECTO DE AHORRO DE ENERGIA	ING. CARLOS ARRAMBIDE	Coordinación del equipo de ahorro de energía Mediciones de parámetros eléctricos Generación de índices de energía Detección de potenciales de ahorro Generación y justificación de proyectos Evaluación y ejecución de proyectos
COORDINACION DE PRODUCCION DEPARTAMENTO DE ACERIA	ING. JOSE L. MOLINA CARDONA	Detección de tiempos muertos Detección de potenciales de ahorro Generación, evaluación y justificación de proyectos Programación tomando en cuenta la energía eléctrica Detección de necesidades de capacitación
COORDINACION MANTENIMIENTO	ING. ARNOLDO GOMEZ	Detección de potenciales de ahorro Detección de necesidades de capacitación Detección de tiempos muertos Implantación de programas de mantto. preventivo Programación de paros programados de acuerdo a los horarios de base y punta
COORDINACION ECOLOGIA	ING. JOSE R. BARAJAS LIZARRAGA	Optimización de procesos Detección de potenciales de ahorro Verificación y control de los equipos de bombeo Implantación de sistemas de medición Control permanente de efluentes y residuos industriales Control en el manejo de residuos, flujos, reactivos, etc.
COORDINACION RELACIONES INDUSTRIALES	SR. CARLOS RAMOS	Detección de potenciales de ahorro Detección de necesidades de capacitación Difusión permanente del programa de energía Seguimiento de avances del proyecto Campañas de concientización a todo el personal

NOTA: Queda a consideración de FUMOSA cualquier cambio, sustitución o asignación del personal propuesto en dicho comité.

General Activities for CADE.

The general activities that members of CADE shall be performing will be divided into five areas as follows:

1. Collection and Analysis of Energy Information..

In this area, members of CADE shall have information about average energy consumption for the whole plant and for each of the areas; permanently collect daily reports on real production, and specific energy consumption; they shall make process line and global energy balances, and supervise the follow up on the reading at the meters trying to have these done continuously. This information will allow them to know the energy efficiency for each department, and on the medium turn, will help determining savings goals.

2. Energy purchase and consumption supervision.

CADE members shall be alert that a control be kept on the power factor, as well as maximum demand both in point time as in base time. For this, it is Important to follow up on the recommendations established on the saving cards that have been evaluated on this subject. It is necessary that the know the impact that energy costs have on production costs, but considering energy within supplies, as water, vapor, chemical reactors, etc. to be able to ponder the cost. This will allow them to have a higher awareness on the significance of savings so they can convey it to the rest of the personnel. also, it is important that they develop contingency plans to face blackouts, in order to prevent spikes in demand.

3. Energy conservation and savings project evaluation

CADE member shall be the main idea and project generators to efficiently use energy and promote use of potential savings; they shall also establish consumption standards and saving goals; analyze savings projects, feasibility and financial evaluation (investment and return). They shall be lobbyists and promoters to have resources assigned for project financing; they shall reevaluate possible projects according to operation changes and plant growth, as well as energy efficiency of new equipment and facilities.

4. Energy Saving Project Implementation.

We recommend that CADE members program production and scheduled maintenance downtime to save energy in equipment and processes, and to supervise startup of new conservation projects, including equipment specifications, all operating elements and perform the follow-up, analyzing the results

5. Broadcast and training.

CADE shall prepare and publish monthly reports with information and results for the Plant's Main office and Management, including costs and energy consumption and specific consumption. Committee members shall interact with all production and backup departments in order to have a collective participation in the management program and energy saving. We recommend that they develop a permanent awareness campaign on efficient energy use in all areas and departments, so that measures and results can be broadcasted at all levels, including prizes and recognition to all personnel that contributes in savings and efficient use of energy.

Energy Saving Committee Responsibilities.

The CADE coordination plays a major roll in all actions takes towards saving energy, since to capitalize on the measures and recommendations presents in the Energy Diagnosis and supported by the rest of the members of the committee, he shall perform the following activities:

a) Integrate an Energy Information System.

In information subjects, it is necessary that **Fundici6n Monclova S.A. de C.V.** establishes a measurement and record system for energy consumption in all areas and operation schedules to make a data base that will allow knowing in greater detail the energy situation at the plant.

Relating production information with energy consumption in the data base, unit consumption information can be obtained, which will set pace to establish consumption goals by process and make comparisons on equipment energy efficiency.

At the same time, a mechanism to monitor and permanently follow-up must be designed to allow detection of any variation in the records. The labor performed by the Work Groups in Diagnosis, as to load recording, can be used as a base to design this mechanism. The information thus generated can backfeed a process statistical control, similar to the one used in total quality programs, affixing the bases to develop an information and results broadcast control system. The idea here is to integrate operations management for each process and all plant personnel in those aspects of energy consumption that relate to the cost of these and the advantages that these savings mean.

b) Inefficiency Detection System.

In most companies there are a series of factors that have a direct relationship to the inefficiencies in energy use. At **Fundici6n Monclova S.A. de C.V.** it is necessary that the coordinator, supported by CADE members, implants a permanent Inefficiency Detection System, that has as central indicator the results and recommendations from the Energy Diagnosis and that it emphasizes its activities in those aspects related to :

1) Excess Illumination: According to the results from measures and recommendations presented in the Diagnosis, as to illumination, evaluate the advantages to the plant in selecting the different illuminated areas in order not to waste energy in those areas where illumination is not required. Also install switches in easy to reach areas with the proper signs.

2) Inadequate Insulation: It is necessary to verify the insulation on steam pipes and other fuels to verify their condition and consequent energy loss. Here, the coordinator with the other committee members, must put pressure the corresponding areas to perform all insulation actions necessary, implementing a follow up until all such anomalies are corrected. This also applies to compressed air, water, gas and oil.

3) Irregular Processes: All historic behavior for all processes shall be revised to detect those changes that are provoking irregularities and that are responsible for variation in energy unitary consumption. For this activity, it is important to have energy usage charts - production with daily data if possible, once the measuring system is installed, much as it is recommended in the Diagnosis

4) Inadequate or badly programmed maintenance:: Maintenance programs must be revised to find out if they are adequate both in scope as in schedule. On this last point, you have to consider the time, in such a way as to use the peak hour to perform these activities.

5) Badly programmed production: Production shekels need to be revised in order to detect if dead times are generated, especially in those processes whose production fluctuates in a serialized manner. With this, the installed capacity can be better used increasing the load factor and making energy usage more efficient.

6) Coordination in starts and down times: It is very important to establish a good coordination between different areas so that down times and startups on different equipment and processes can be done in such a way as to prevent "peaks" in demand, and at the same time prevent them from being in operation when there is no need for them to operate.

7) Lack of training: Frequently in industry, training given to operations personnel forgets aspects related to energy savings and efficient use, so we recommend a frequent revision on each process how much influence this factor has, and from this, program periodic training courses at all levels on this subject.

8) Inadequate Equipment: Performance and efficiencies shall be revised periodically for different equipment in order to prevent that their obsoleteness is provoking deviations in energy consumption. A deep and constant evaluation on this situation can provide enough elements so that at certain time, a decision can be made on those equipment that are no longer adequate for the process, either by the loss of useful life, it's limited capacity, maintenance problems they generate, operative inefficiency, etc.

9) Product loss or shrink: A way to detect inefficiency in the process is to establish an accounting mechanism for product loss of shrink. Here, the energy cost that they generate shall be present in order to objectively evaluate the causes that originate them and take actions to minimize them.

10) Process delays: Generally delays are caused by maintenance problems, training, raw materials or machinery wear. It is recommended to define strategies to counter them.

c) Actions to Increase Energy Efficiencies.

Derived from the Inefficiency Detection System to be implemented at the plant by the Committee and the Coordinator, there must be a series of activities generated precisely to systematically and efficiently counter those factors mentioned, that could be cause for inadequate or excessive energy use. These activities are :

1) Comparative Operation Analysis: The statistical analysis of operation results is a basic tool to measure equipment and process efficiency. The intent here is to periodically compare energy usage related to production, identifying those elements within the process that influence in high energy performance to reinforce their permanence. When comparing historic results, CADE shall select the best index recorded and try to repeat production conditions that were, to achieve the same results, always keeping as a basic objective, to establish them as normal operating conditions. The Diagnosis contemplates the incorporation of a section fro energy indexes by process including their respective charts. The Committee shall continue this task.

2) Establishing consumption goals: More efficient historic records will set pace for the committee to establish energy consumption goals by process (paste preparation, paper machines, co-investment, etc.). This goals, to start with, shall be conservative in order to, slowly, be modified until they equal the most efficient records reached history wise. Here we recommend that the Committee keeps a constant following on the compliance of the established goals and that the make open commitments with those responsible for the processes to guarantee compliance.

3) Training: Training shall be given at two levels: on one hand, it is recommended that personnel be trained at operative level to get a more efficient use of energy, and to make them aware of the it's roll within the processes and its impact on production. This training must involve both production personnel and maintenance personnel. On the other hand, support personnel (Offices, Sales, Shipping, Management, Programming) requires training to hone their knowledge on energy accounting, energy indexes, energy balances, etc. This activity is fundamental so that the Energy Coordinator can count with an efficient support team that can guarantee results in their energy lobbying and control efforts. Also, a good training in both levels will optimize all the recommendations and savings opportunities presents in the Energy Diagnosis.

4) Efficiency analysis in regard to installed capacity: At the same time as the comparative operation analysis, the CADE shall revise the results of those measures and compare them to the installed capacity, as one more way to measure the performance of their equipment. This will also set the pace to determine the wear of these and their obsolescence. More detailed analysis can give fundamental elements to substitute and change some of the equipment and to incorporate other more efficient ones.

5) Scheduled Revision of Maintenance Operations: We recommend that in the maintenance programs a special emphasis be made on those referred to the highest energy consumption equipment (air compressors, pumps, fans, hydraulic system, boilers, motors, etc.) to prevent that deterioration caused by continuos use or natural wear and inadequate operation lean on higher consumption. Also, the power supply lines shall not be unattended, (cables, installations, pipes etc.) nor the instruments, gages, and regulators for their control. The maintenance programs, besides recording most recurrent failures and causes that made them happen, shall also include suggestions to expedite their own activities and prevent delays generated by these concepts.

Specific functions for CADE members according to their activities and responsibilities.

A) Coordinator.

1. Collect information on real and programmed production.
2. Collect production and down time.
3. Collect electric measurements.
4. Collect energy indexes, supported by different areas (kWh/Ton).
5. Detect saving potential.
6. Generate projects.
7. Assign responsibilities.
8. Project Follow ups.
9. Generate reports based on individual reports.
10. Generate reports for Management and General Office.
11. Detect training needs.
12. Update information related to energy.
13. Generate ideas towards energy saving..

B) Maintenance.

1. Generate, analysis and interpretation of energy indexes..
2. Identify new technics or technologies that optimize processes and save electric energy, fuel steam, raw material, etc.
3. Update ion information related to energy consumption
4. Detect down times.
5. proposal presentation to the committee to reprogram production as a function of energy saving opportunities detected.
6. Generate reports to Committee Coordinator
7. Generate ideas towards energy saving
8. Detect training needs.
9. Implement effective preventive and predictive maintenance programs

C) Industrial Relations.

1. Coordination of training and awareness courses
2. Broadcast and promotion of training courses for energy savings
3. Permanent broadcast of propaganda for energy savings program
4. Establish contacts with organizations such as FIDE, CONAE, U3E, etc., to keep informed on activities related to energy saving and efficient use.
5. Distribute information obtained to each Committee member
6. Search for administrative support that will promote energy savings in the company from all personnel.
7. Generate activities cronogram for energy saving programs.
8. Follow up on project progress
9. Coordination of personnel in the execution..
10. Support in Management and Administrative needs
11. Generate list of consulting companies, private and/or public institutions with whom to count on for training support.
12. Update on information related to energy
13. Generate reports to **CADE** coordinator

D) Management office.

1. Supply ideas as to technical feasibility in site development for a project.
2. Collaborate in cronogram design for each project with potentials follow up personnel
3. Responsibility designation to execute projects in energy saving and personnel handling.
4. Requirement application for project development.
5. Develop energy saving projects.
6. Interaction with technical and quality assures in project development
7. Generate progress and result reports on follow-up of potential savings.
8. Update information related to energy
9. Generate ideas for energy savings

E) Production areas .

1) Forward ideas on technical implementation feasibility for energy savings, quality and productivity.
1. Update information related to energy
1) Weekly accounting of machinery and equipment operation times.
2) Detect dead times.
3) Program production keeping in mind electric energy costs.
4) Process Optimization.
5) Process Modernization.
6) Waste elimination .
7) Installation of measuring systems.
8) Unitary costs for services and supplies.
9) Generate reports to CADE coordinator.

F) Ecology Area .

1) Generation, analysis and interpretation of energy indexes.
2) Control in handling residues, sludge, reactive, flows etc.
3) Process Optimization.
4) Implement measuring systems (water, gas, electricity, reactive,)
5) Generate ideas for energy savings.
6) Generate reports to CADE coordinator.

CADE operating mechanisms.

Next we present some recommendations that try to expedite activities and meetings of **CADE** members.

A) Periodic Meetings .

The committee shall meet weekly at least while the main measures and recommendations from the Savings Plan are implemented. Later, they could space out the meetings on a biweekly basis but always keeping enough flexibility and communication to provide an adequate follow-up, control and monitoring of all activities linked to energy savings.

The coordinator is the most indicated to call to a meeting and define the subject for the day, but any member, based on the priority of an activity or contingency, can call the committee to a meeting, always through the coordinator. In these meetings, keep attendance record and agreement minute, establishing on this, when ever possible, concrete commitments, compliance dates and personnel responsible to carry out recommended tasks.

B) Coordinator attributions.

The coordinator has the faculty to call meeting as necessary to revise and keep a follow-up or results of a certain activity, he is responsible to define the work agenda for each meeting and can delegate functions and specific activities to each one of the members, regardless of the tasks and responsibilities of each one in the committee. The coordinator shall receive all reports and data necessary to be able to develop his activities and he will define priorities to the tasks to be performed. He will be in charge of expediting information flow between different areas and shall keep them communicated so as to prevent task stumbles. Also, he shall present progress and result reports periodically to Main Office and request, when necessary, their support and lobbying with the different areas to expedite the measure pretended to be implemented. When considered necessary, e can name a substitute so the work of the committee isn't delayed. In any case, he will be responsible before the committee on the success in energy savings for the company.

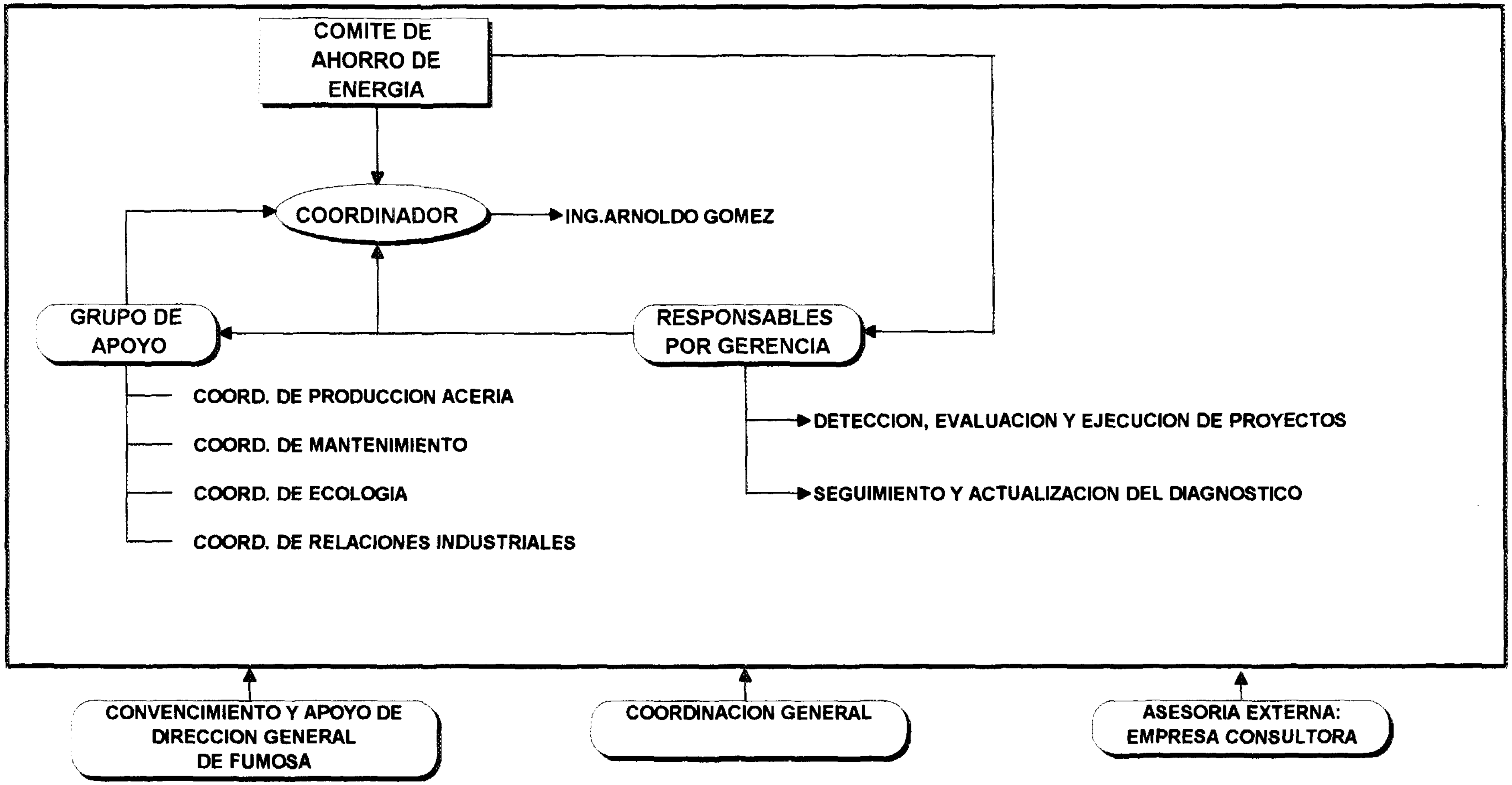
C) Energy Audits.

Periodically, the coordinator will assign committee members to visit different areas and physically see that the measures they recommended have been carried out. It is necessary to make the measurements to determine the degree of efficiency achieved, as a kind of audit, and being the case, reinforce such actions with more specific measure that will demand a more detailed monitoring and control by the area's responsible and the rest of the members of the committee.

D) Detect saving opportunity areas.

All Committee members have the responsibility to detect and give notice of their energy savings opportunity, in their own areas as well as in the whole plant. The intention is not to place in evidence the lack of aptitude for energy savings of the personnel, but to contribute so that the company can reduce production costs and to install an energy saving culture among all personnel and all processes. The purpose to have all committee members the know these opportunity areas so that among them they can establish the most ideal measures to take advantage of them. We recommend that they don't discard any opportunity until advantages and disadvantages to us it have been analyzed objectively. It is necessary to reject light judgment and using imagination to prevent falling into operation vices or "shop blindness". Every proposal shall be received in good manner and should be analyzed in detail. With this you can prevent a discouraging environment or total insolence. The coordinator plays a mayor roll in this tasks.

CUADRO 2
ORGANIGRAMA OPERATIVO DEL CADE



Nota: Queda a consideración de FUMOSA, cualquier cambio, sustitución o reemplazo del personal propuesto dentro del comité de ahorro de energía.

F) Opportunity list for Energy Savings

In the basic document about the committee, there are preliminary lists of savings opportunities that have been detected throughout the course of this Energy Saving Program development. These lists are not exhaustive and should serve as raw material for the committee to start their tasks in full gear. It is intended for those responsible in each area to be in charge of putting these opportunities in practice, always having the support from the committee members. In any case for the majority of these opportunities, saving cards should be made, which generally include the methods to perform the evaluation. These should serve as examples to develop those necessary and also they require a detail follow-up and monitoring to evaluate the results.

G) Energy Saving Cards.

We recommend that the committee members, to do an objective evaluation of the opportunities detected, follow the form and methods presented for each one of the saving cards which will be included in the final diagnosis report. We also consider that the information and evaluation presented this way will facilitate and contribute to the justification of any investment project to save energy for the plant. For the rest, personnel attending training sessions will have enough information to be able to use the methodology required to evaluate any energy saving opportunity.

H) Monitoring and Follow-up.

This must be one of the permanent activities of the committee. It is convenient that they divide each one of the saving opportunities being generated among them, in order to perform a detailed follow-up on the results, but this must be after a measuring system that allows the committee to know what the real consumption is for different equipment and how they manifest their efficiencies

I) Energy specific consumption.

With the information to be included in the Program's results, the committee can determine specific energy consumption for each of the main processes on the plant. in order to have efficiency measuring parameters to periodically evaluate consumption and determine actions to take to improve these performance.

J) Establishing Consumption Goals.

The committee will also have sufficient information in the Program's results, to establish consumption goals for each process, and provide amore efficient energy use.

K) Permanent awareness campaign.

It is important that the committee performs awareness campaigns on energy savings, promoting courses, creating posters, publishing progress and results in the company's internal magazine, as well as in any kind of publicity and incentive material (key chains, stickers, sings, etc.) and specialized training courses to achieve a savings culture at **Fundisión Monclova S.A. de C.V.**

Recommendations for a personnel awareness campaign.

To get positive results in the energy saving measures proposed during the second level energy diagnosis performed at **Fundición Monclova, S.A de C.V.** the continuation of the same is necessary.

Motivation oriented on energy is one of the phases that an Energy Saving Program should observe which should be sufficiently clear to obtain the desired success. Since with a good awareness to personnel we can get better results in the program, they should be participants in all aspects of efficient and rational use of energy in the plant.

It is common to find negative actions in the people once the indications to make an adequate energy use were given. This is the time to reinforce measures, in order to make them feel as an important part of the company, expressing the importance that energy has today and in the future.

Important progress can be achieved when personnel collaborates and also when they know how to take advantage of efficient energy ideas, since the are the ones living field conditions and in many cases all they need is a guide. CADE or the energy demand controller or the awareness campaigns will be useless if there is no motivated personnel to carry it out.

Based on the functions recommended for CADE, one of them is to allow integration at all levels, to achieve objectives, so we propose a series of activities that could be organized to establish a motivational program.

- Talks to supervisors
- Talks to personnel
- Talks to Management
- Results presentation
- Energy index evaluation
- Poster distribution
- Energy Mural
- Movie exhibition
- Conferences and seminars
- Revision of the Energy Savings Program
- Development of Energy Manuals
- Increase frequency of CADE meetings
- Contests and campaigns
- Personnel Family Visits
- Energy album
- Biweekly Informative Bulletin
- Give courses

We consider that one of the most indispensable parts on any program is the efficient use of energy in industry, in awareness, which must be maintained in good direction starting at the highest level all the way to the lowest job that a person can perform at a work center.

As a program for awareness talks in Energy Savings, the following points should be taken into consideration :

1.- ¿ What is Energy Savings ?

a) Nation wide
b) Company wide
c) For Final user

2.- Advantages of Energy Saving in the company.

3.- Energy saving opportunities detection in:

a) Offices
b) General Installations
c) Production lines
d) General equipment

4.- Energy Saving Recommendations at :

a) Home
b) Commerce
c) Industry

The consulting company's experience in energy saving projects has gone to the conclusion that if the industry establishes a purely technical method whose objective were to optimize energy, its results would be diminished, if not reinforced on the side with an awareness program to personnel, users of any kind of equipment of devise that uses energy. This problem is frequent and can present itself for different reasons as follows :

New personnel that is not trained.
Hurries after work shift.
Generation of destructive ideas :
- ¡ There are to many and the count to much!
- ¡ For what !
- ¡ I don't pay and the company has to much money!
- ¡ They are not mine !

A work plan must be designed to prevent these before they happen and result in unnecessary energy use. For this CADE will support Energy Saving campaigns, in which they invite personnel to participate through specialized personnel talks, enhancing the importance of energy savings both in and out of the work center.

To have trained personnel, is to be disposed to obtain successfully any goal that **Fundición Monclova, S.A de C.V.** takes on.

6.3 STATISTICAL ANALYSIS OF THE ARC FURNACES OPERATION

6.3 CONTENTS

6.3.1 OBJECTIVE .

Through statistical analysis of available information, obtain improvement areas in operation form for arc furnaces and establish information reliability

6.3.2 CURRENT SITUATION .

There are two arc furnaces made by Whiting, 4.5 and 5 MVA respectably in steel area, which work in two shifts, always being off from 15:00 to 23:00 hours Monday to Saturday. There are two shift managers.

Main products in these furnaces are, steel to make granules and steel to fabricate rolls.

Furnaces have individual smoke exhaust.

Ferrous material loading into the furnaces starts with filling the hopper at the yard with out being weighted beforehand, later it is filled with the electromagnet without being weighted, later it is taken to reclaiming area and with a crane it is neared to the furnace which is open on top and finally the hopper is emptied. Supposing by inside furnace level the load obtained, this not considering alloys that are the smaller percentage and this are usually loaded at the end of the melt (refining)

The electric measuring system used to record consumption by melt, is done with a PLC which takes readings at the beginning and end of each melt (if possible and without any problems, these are taken at the precise moment).

For each melt a report is generated that records : starting and finishing time, metal load and alloys. energy consumption in kWh/melt, delays of faults in different kinds such as maintenance, operation, etc.

We could not find the management's use of melt records to make improvements or corrective actions.

6.3.3 PROPOSED SITUATION.

Based on the results obtained from statistical analysis performed on the arc furnaces, the following recommendations were obtained:

6.3.3.1 With the melt sheets it is important to have reliability on their content and that they be analyzed daily by management and operations, so that the faults on one day don't occur the next.

this has the potential of reducing the standard deviation for energy consumption in more than half and should be reflected in as decrease of the same order (aprox. 210 kWh/TMC) in its average.

6.3.3.2 So that no errors occur in the average monthly measurements higher than 1% (we had a difference higher than 7% between one month and the next in furnace #1 and no difference in furnace #2), it is important to have an exhaustive following of the basic variable such as : kWh and metal load looking for a good measuring system.

6.3.3.3 There was a difference of more than 20 kWh/TMC between one furnace man and the other, for granule production and this was repetitive. And with the other furnace man there was an improvement in kWh/TMC better that 16 for special steel production and it was repetitive. So if the self-train between them there will be this improvement in expected consumption.

6.3.3.4 It was confirmed that energy consumption between initial melt and normal melts was around 50 kWh/TMC for the initial melt.

6.3.3.5 We recommend using other systems to use the heat in exhaust gases at the outlet of the furnace, but these will be lost in the information noise if there is no reliable system to acquire data.

6.3.3.6 If there is a reliable measuring system, this can be used to optimize operation practices with the consequent saving by reducing energy index and increased performance (but don't forget that a daily follow-up must be made by those responsible)

6.3.4 INFORMATION RELIABILITY.

We found a difference of +9.7% in electric energy consumption between the PLC for furnace 1 and the electric network analyzer (OHP) and a 3.6% in furnace 2.

Looking at the slag and fines (performance) we have, global data for FUMOSA were found to have a global performance from January to September / 96 at 97% according to reports from *warehouse and shipment*.

If we take data from day to day melts, we find that the difference in energy consumption between the PLC and OPH is constant regardless of the furnace, so it is possible to use these information in the analysis.

We found that if the information in a single day is taken from melt to melt, between the report in the melt sheet and the OPH we found differences that were not constant, indicating that the furnace man is not taking the information (consumption readings) at the exact moment. This increases the standard deviation of the information.

6.3.5 MELT SHEET STATISTICAL ANALYSIS .

This section is based on the tables that are found in section 1.7 and only those having a statistically significance over 95% will be concluded.

6.3.5.1 Comparison from furnace 1 vs. furnace 2 in August /96 (Table 1).

Significant differences were found in the energy index and in delay times, so these are two separate universes that can't be mixed

6.3.5.2 Comparison of granules vs. roll for the month of August /96 (Table 2).

Significant differences were found in practically every parameter and in the furnaces, so they are different for results both to produce granules as to fabricate rolls

6.3.5.3 Comparison between granules in furnace 1 vs. granules in furnace 2 in August/96 (Table 3).

Significant differences were found in the energy index and in delay times, so these are two separate universes that can't be mixed even if they are producing the same kind of granules.

6.3.5.4 Comparison of specials in furnace 1 vs. specials in furnace 2 fro August /96 (Table 4).

The only statistically significant difference found in total furnace load and thus in kWh and due to these differences in melt times.
Strangely there is no difference in energy index and this is due to the high dispersion of data with more than 71% variation coefficient.

6.3.5.5 Comparison from furnace man 1 vs. to furnace man 2 in August /96 for granules in furnace 1 (Table 5).

Significant statistical differences were found in energy consumption furnace man 1 using less (26.34 kWh/TCM).

6.3.5.6 Comparison from furnace man 1 vs. furnace man 2 in August/96 for specials in furnace 1 (Table 6).

Differences were found that statistically were not significant due to the high dispersion (more than 10%) in energy consumption, furnace man 2 consumed less (16.79 kWh/TCM).

6.3.5.7 Comparison of furnace man 1 vs. furnace man 2 for August /96 for granules in furnace 2 (Table 7).

We found differences that statistically were not significant because there was a time difference of 28 minutes in maintenance time., that is statistically significant in energy consumption, furnace man 1 consumed less (9.08 kWh/TCM).

6.3.5.8 Comparison of furnace man 1 vs. furnace man 2 for August /96 for specials in furnace 2 (Table 8).

Statistically they were not significant due to high dispersion and few data in energy consumption, furnace man 2 consumed less (20.98 kWh/TCM).

6.3.5.9 Comparison of initial melts in furnace 1 vs. furnace 2 for August /96. (Table 9).

There were differences that were statistically significant in practically every data, furnace 1 consumed less (90.97 kWh/TCM).

6.3.5.10 Comparison of initial melts in furnace 1 vs. furnace 2 for September/96. (Table 10).

In energy consumption there were no statistically significant differences since the time difference of the melts was 22 minutes higher for furnace 1.

6.3.5.11 Comparison of granule melts in furnace 1 vs. furnace 2 for Agosto/96. (Table 11).

Statistically significant differences were found in energy consumption, furnace 1 consuming less. (24.54 kWh/TCM).

6.3.5.12 Comparison of granule melts in furnace 1 vs. furnace 2 for September/96.(Table 12).

We found differences that were not significant in energy consumption, probably due to difference in reliability of measuring systems (more than 12%).

6.3.5.13 Comparison of granule melts in furnace 1 in August/96 vs. September/96. (Table 13).

We found differences that were statistically significant in energy consumption, probably due to difference in reliability of measuring systems, this being more than 49.20 kWh/TCM (7.5%).

6.3.5.14 Comparison of granule melts in furnace 1 in August/96 vs. September/96. (Table 14).

We found differences that were statistically significant in energy consumption, probably due to difference in reliability of measuring systems, this being more than 13.8 kWh/TCM (2%).

6.3.5.15 Comparison of granule melts in furnace 1 in August/96 in shift vs. initial (Table 15).

We found differences that were not statistically significant in energy consumption, due to high data dispersion, initial melts being higher by 19.43kWh/TCM.

6.3.5.16 Comparison of granule melts in furnace 1 in September/96 in shift vs. initial (Table 16).

We found differences that were not statistically significant in energy consumption, due to high data dispersion, initial melts being higher by 48.88kWh/TCM.

6.3.5.17 Comparison of granule melts in furnace 1 in August/96 in shift vs. initial (Table 17).

We found differences that were statistically significant in energy consumption, , initial melts being higher by 47.52kWh/TCM.

6.3.5.18 Comparison of granule melts in furnace 1 in August/96 in shift vs. initial (Table 18).

We found differences that were statistically significant in an 85% in energy consumption, initial melts being higher by 23.31kWh/TCM.

6.3.5.19 Comparison of melts from furnace man 1 vs. furnace man 2 (Tables 19 to 26).

In these tables we used previous data statistically cleaned and concur with the conclusions in the previous tables.

6.3.6 INFORMATION HANDLING.

The following data was collected from the melt sheets in furnace 1 and 2 for August (complete), September (complete) and October only those melts monitored by OPH

- Melt number
- Date
- Furnace
- Gross melt time
- Time connected
- Consumed kWh
- Seven kinds of additions
- Total Metal load
- Energy index (kWh/TCM)
- Kind of steel
- Pick difference
- Furnace man
- operative and maintenance delays.

For all of these; average, standard deviation and percentage of variation coefficient; were calculated.

To clean the information, we proceeded to separate the melt by

- Day start
- Shift (initial melt are excluded)
- Granules
- Special (primarily rolls).
- Months
- Furnaces
- Furnace men

The melts that had two standard deviations outside the medium were separated and the information was verified since these were data which had measurement errors (i.e. some melts with less than 500 kWh/TMC that had an error in the PLC reported)

We proceeded to apply the statistical "t" to establish statistically significant differences in mediums that can set some useful behaviors. (repeatable)

6.3.7 SUMMARY TABLES.

This section lists all tables with results from statistical analysis performed in arc furnaces as well as the relationship between the two furnaces and their operation

6.3.8 BASE INFORMATION (DATA BASE).

Here we have the total data base generated by the for statistical analysis, tables from the monitoring period OPH vs. PLC and tables at inlet and outlet of raw materials for the current year.

Table. 1

COMPARISON OF FURNACE W-1 vs. W-2

Furnace	W-1		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maint.	Gross time
Data	77	77	71	76	66	65	65	7	0	77	77		77		77	77	77
Average	151.17	4043.70	2.36	1.98	0.59	0.5	0.50	1.59	0.0	5.63	717.38		1724.68		40.05	24.81	216.03
Desv.Est	50.34	883.72	0.34	1.43	0.34	0.0	0.00	0.45	0.0	0.66	123.07		17.36		30.61	23.99	79.53
C.Var.	33.30	21.85	14.4	72.3	57.3	0.0	0.00	28.3	0.0	11.70	17.16		1.01		76.43	96.71	36.82

Furnace	W-2		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temp.	Worker	Col-Col	Maint.	Gross time
Data	76	76	69	75	58	58	57	10	3	76	76		76		76	76	76
Average	147.54	4222.20	2.37	1.96	0.63	0.5	0.50	1.31	0.7	5.53	761.74		1723.95		52.07	40.01	239.62
Desv.Est	62.48	764.42	0.60	1.08	0.64	0.1	0.03	0.59	0.8	0.20	120.12		12.44		39.22	36.84	85.17
C.Var.	42.35	18.10	25	55	102	13	5.34	44.9	102	3.62	15.77		0.72		75.33	92.07	35.54

Δ	-3.63	178.50	0.01	-0.02	0.04	0.0	0.00	-0.28	0.7	-0.10	44.36		-0.73		12.01	15.21	23.59
t	0.40	1.34	0.14	0.11	0.41	###	1.00	1.10		1.24	2.26		0.30		2.11	3.02	1.77
°L	145	150	109	141	85	57	56	17		90	153		139		144	130	152

Table. 2

COMPARISON OF GRANULATED METAL vs. SPECIAL STEEL

W-1

GRANULATE METAL

Furnace	W-1		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	66	66	66	66	65	65	65	1	0	66	66		66		66	66	66
Average	138.29	3838.71	2.44	1.53	0.55	0.50	0.50	1.40	0.00	5.52	695.21		1730.00		35.12	21.14	194.55
Desv.Est	36.80	508.56	0.18	0.25	0.16	0.00	0.00	0.00	0.00	0.13	90.42		0.00		8.04	18.04	48.87
C.Var.	26.61	13.25	7.19	16.09	28.20	0.00	0.00	0.00	0.00	2.30	13.01		0.00		22.88	85.34	25.12

SPECIAL STEEL

Furnace	W-1		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	21	21	7	17	6	1	3	10	0	21	21		21		21	21	21
Average	236.10	5637.81	2.61	5.01	2.20	0.50	1.70	1.63	0.00	6.80	859.41		1696.19		63.48	41.38	350.76
Desv.Est	55.00	1470.84	2.23	2.31	1.44	0.00	1.08	0.47	0.00	1.56	150.40		22.47		51.17	36.63	110.45
C.Var.	23.29	26.09	85.29	46.08	65.24	0.00	63.63	28.78	0.00	23.66	17.50		1.32		80.62	88.52	31.49

Δ	199.30	5129.25	2.44	4.76	2.04	0.50	1.70	1.63	0.00	6.47	768.99		1696.19		55.44	23.34	301.89
t	16.32	15.98	0.52	0.37	0.05		2.72	10.99		6.24	23.43		345.97		4.69	1.15	12.49
°L	22	20	2	1	0		2	9		6	20		20		25	28	20

W-2

GRANULATE METAL

Furnace	W-2		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	57	57	57	57	57	57	57	0	0	57	57		57		57	57	57
Average	126.65	3980.07	2.45	1.50	0.55	0.50	0.5	0.00	0.00	5.49	724.81		1730.00		41.82	41.30	209.77
Desv.Est	43.93	537.53	0.15	0.00	0.16	0.00	0.03	0.00	0.00	0.10	95.43		0.00		7.56	41.41	62.97
C.Var.	34.68	13.51	6.14	0.00	28.5	0.00	5.34	0.00	0	1.84	13.17		0.00		18.08	100.26	30.02

SPECIAL STEEL

Furnace	W-2		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	26	26	15	23	2	2	0	13	3	26	26		26		26	26	26
Average	208.08	4841.46	2.25	3.95	3.15	1.65	0	1.38	0.73	5.94	827.00		1704.23		73.27	36.08	317.42
Desv.Est	63.10	829.22	1.40	1.86	3.04	0.92	0	0.80	0.75	0.88	149.08		11.72		54.43	16.35	83.25
C.Var.	30.32	17.13	61.95	47.12	96.5	55.7	0	57.46	102	14.86	18.03		0.69		74.28	45.32	26.23

Δ	164.15	4303.93	2.10	3.95	2.99	1.65	-0.03	1.38	0.73	5.84	731.57		1704.23		65.71	-5.33	254.45
t	12.87	26.47	0.53	10.18	0.08	2.54				7.24	25.02		741.39		5.95	0.33	15.46
°L	28	25	2	22	0	1				5	25		25		29	44	26

Table. 3

COMPARISON OF GRANULATED METAL W-1 vs. GRANULATED METAL W-2

Furnace	W-1		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	66	66	66	66	65	65	65	1	0	66	66		66		66	66	66
Average	138.29	3838.71	2.44	1.53	0.55	0.50	0.50	1.40	0.00	5.52	695.21		1730.00		35.12	21.14	194.55
Desv.Est	36.80	508.56	0.18	0.25	0.16	0.00	0.00	0.00	0.00	0.13	90.42		0.00		8.04	18.04	48.87
C.Var.	26.61	13.25	7.19	16.09	28.20	0.00	0.00	0.00	0.00	2.30	13.01		0.00		22.88	85.34	25.12

Furnace	W-2		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	57	57	57	57	57	57	57	0	0	57	57		57		57	57	57
Average	126.65	3980.07	2.45	1.50	0.55	0.50	0.5	0.00	0.00	5.49	724.81		1730.00		41.82	41.30	209.77
Desv.Est	43.93	537.53	0.15	0.00	0.16	0.00	0.03	0.00	0.00	0.10	95.43		0.00		7.56	41.41	62.97
C.Var.	34.68	13.51	6.14	0.00	28.5	0.00	5.34	0.00	0	1.84	13.17		0.00		18.08	100.26	30.02

Δ	-11.64	141.36	0.01	-0.03	-0.01	0.00	0.00	-1.40	0.00	-0.03	29.60		0.00		6.70	20.16	15.23
t	1.58	1.49	0.21	1.00	0.23					1.54	1.76				4.76	3.41	1.48
ºL	112	118	123	65	120					122	118				122	75	107

Table. 4

COMPARISON OF SPECIAL STEELS W-1 vs. SPECIAL STEELS W-2

Furnace	W-1		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	21	21	7	17	6	1	3	10	0	21	21		21		21	21	21
Average	236.10	5637.81	2.61	5.01	2.20	0.50	1.70	1.63	0.00	6.60	859.41		1696.19		63.48	41.38	350.76
Desv.Est	55.00	1470.84	2.23	2.31	1.44	0.00	1.08	0.47	0.00	1.56	150.40		22.47		51.17	36.63	110.45
C.Var.	23.29	26.09	85.29	46.08	65.24	0.00	63.63	28.78	0.00	23.66	17.50		1.32		80.62	88.52	31.49

Furnace	W-2		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	26	26	15	23	2	2	0	13	3	26	26		26		26	26	26
Average	208.08	4841.46	2.25	3.95	3.15	1.65	0	1.38	0.73	5.94	827.00		1704.23		73.27	36.08	317.42
Desv.Est	63.10	829.22	1.40	1.86	3.04	0.92	0	0.80	0.75	0.88	149.08		11.72		54.43	16.35	83.25
C.Var.	30.32	17.13	61.95	47.12	96.5	55.7	0	57.46	102	14.86	18.03		0.69		74.28	45.32	26.23

Δ	-28.02	-796.35	-0.36	-1.06	0.95	1.15	-1.70	-0.25	0.73	-0.66	-32.42		8.04		9.79	-5.30	-33.34
t	1.63	2.21	0.39	1.56	0.43					1.72	0.74				0.63	0.62	1.15
ºL	47	31	9	32	1					31	45				46	27	38

Table. 5

COMPARISON OF BATCH WORKER No1 vs. BATCH WORKER No.2 IN W-1 (GRANULATED METAL)

Furnace	W-1		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	25	25	25	25	25	25	25	0	0	25	25		25	1	25	25	25
Average	125.56	3581.36	2.44	1.50	0.56	0.50	0.50	0.00	0.00	5.50	651.16		1730.00		36.08	17.64	179.28
Desv.Est	24.35	248.53	0.17	0.00	0.17	0.00	0.00	0.00	0.00	0.00	45.19		0.00		15.64	15.16	36.54
C.Var.	19.39	6.94	6.80	0.00	29.61	0.00	0.00	0.00	0.00	0.00	6.94		0.00		43.34	85.94	20.38

Furnace	W-1		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	31	31	31	31	30	30	30	1	0	31	31		31	2	31	31	31
Average	133.10	3758.29	2.42	1.56	0.57	0.50	0.5	1.40	0.00	5.55	677.49		1730.00		34.23	21.42	188.74
Desv.Est	27.45	381.21	0.21	0.36	0.17	0.00	0	0.00	0.00	0.18	61.63		0.00		8.44	12.61	38.77
C.Var.	20.63	10.14	8.57	22.96	30.5	0.00	0	0.00	0	3.32	9.10		0.00		24.66	58.87	20.54

Δ	7.54	176.93	-0.02	0.06	0.01	0.00	0.00	1.40	0.00	0.05	26.34		0.00		-1.85	3.78	9.46
t	1.09	2.09	0.41	1.00	0.15					1.37	1.84				0.53	1.00	0.94
°L	56	54	56	30	54					30	55				36	48	55

Table. 6

COMPARISON OF BATCH WORKER No1 vs. BATCH WORKER No.2 IN W-1 (SPECIAL METAL)

Furnace	W-1		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	9	9	2	9	1	1	2	3	0	9	9		9	1	9	9	9
Average	223.56	5523.44	1.05	5.13	1.50	0.50	1.55	1.60	0.00	6.47	852.69		1702.22		88.44	42.11	354.11
Desv.Est	61.42	1452.90	0.07	2.51	0.00	0.00	1.48	0.69	0.00	1.49	91.80		6.67		75.82	46.01	141.57
C.Var.	27.47	26.30	6.73	48.84	0.00	0.00	95.80	43.30	0.00	23.09	10.77		0.39		85.73	109.25	39.98

Furnace	W-1		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	7	3	0	3	0	0	0	2	0	3	3		3	2	3	3	3
Average	239.43	6069.00	5.50	5.76	2.23	0.00	2	1.60	0.00	7.29	835.90		1700.00		82.43	29.29	351.14
Desv.Est	62.69	1448.47	0.00	2.37	2.14	0.00	0	0.46	0.00	1.69	107.14		0.00		53.32	12.72	105.78
C.Var.	26.19	23.87	0.00	41.17	95.7	0.00	0	28.98	0	23.24	12.82		0.00		64.69	43.45	30.12

Δ	15.87	545.56	4.45	0.63	0.73	-0.5	0.45	0.00	0.00	0.82	-16.79		-2.22		-6.02	-12.83	-2.97
t	0.51	0.56		0.39						0.75	0.24				0.15	0.75	0.04
°L	15	5		5						4	4				7	11	7

Table. 7

COMPARISON OF BATCH WORKER No1 vs. BATCH WORKER No.2 IN W-2 (GRANULATED METAL)

Furnace	W-2		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	26	26	26	26	26	26	26	0	0	26	26		26	1	26	26	26
Average	109.42	3699.27	2.42	1.50	0.54	0.50	0.5	0.00	0.00	5.46	677.13		1730.00		50.69	28.31	188.42
Desv.Est	23.46	277.40	0.18	0.00	0.14	0.00	0	0.00	0.00	0.14	45.07		0.00		43.62	16.29	59.54
C.Var.	21.44	7.50	7.59	0.00	25.2	0.00	0	0.00	0	2.49	6.66		0.00		86.05	57.55	31.60

Furnace	W-2		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	18	18	18	18	18	18	18	0	0	18	18		18		18	18	18
Average	112.06	3789.89	2.47	1.50	0.56	0.50	0.5	0.00	0.00	5.52	686.20		1730.00		44.83	56.22	213.11
Desv.Est	20.04	310.58	0.10	0.00	0.16	0.00	0	0.00	0.00	0.06	54.22		0.00		11.98	62.68	64.09
C.Var.	17.89	8.19	3.93	0.00	29.1	0.00	0	0.00	0	1.17	7.90		0.00		26.72	111.49	30.07

Δ	2.63	90.62	0.04	0.00	0.02	0.0	0.00	0.00	0.00	0.06	9.08		0.00		-5.86	27.91	24.69
t	0.40	0.99								1.98	0.58				0.65	1.85	1.29
°L	42	36								39	34				31	19	37

Table. 8

COMPARISON OF BATCH WORKER No1 vs. BATCH WORKER No.2 IN W-2 (ESPECIAL METAL)

Furnace	W-2		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	8	8	5	8	0	0	0	4	1	8	8		8	1	8	8	8
Average	200.38	4729.75	2.06	3.68	0.00	0.00	0	1.03	0.70	5.56	849.54		1706.25		50.38	40.63	291.38
Desv.Est	26.74	483.28	1.23	1.44	0.00	0.00	0	0.84	0.00	0.18	72.06		11.88		9.15	21.95	43.20
C.Var.	13.34	10.22	59.61	39.29	0.0	0.00	0	82.16	0	3.32	8.48		0.70		18.16	54.02	14.83

Furnace	W-2		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	9	9	5	8	1	1	0	5	2	9	9		9	2	9	9	9
Average	179.33	4683.22	2.40	2.96	5.30	1.00	0	1.50	0.75	5.66	828.56		1706.67		83.78	32.22	295.33
Desv.Est	28.66	285.04	1.75	1.42	0.00	0.00	0	0.33	1.06	0.35	50.37		16.58		77.05	14.39	78.16
C.Var.	15.98	6.09	72.83	47.92	0.0	0.00	0	22.11	141	6.21	6.08		0.97		91.98	44.64	26.46

Δ	-21.04	-46.53	0.34	-0.72	5.30	1.0	0.00	0.48	0.05	0.10	-20.98		0.42		33.40	-8.40	3.96
t	1.57	0.24								0.74	0.69				1.29	0.92	0.13
°L	17	12								14	14				8	13	14

Table. 9
COMPARISON OF INITIAL MELTINGS W-1 vs INITIAL MELTINGS W-2

Furnace	W-1		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	17	17	17	17	17	17	17	0	0	17	17		17		17	17	17
Average	127.82	3665.59	2.50	1.50	0.50	0.50	0.5	0.00	0.00	5.50	666.47		1730.00		36.35	19.00	183.18
Desv.Est	31.63	488.34	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	88.79		0.00		7.35	8.66	34.23
C.Var.	24.75	13.32	0.00	0.00	0.0	0.00	0	0.00	0	0.00	13.32		0.00		20.21	45.58	18.69

Furnace	W-2		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	18	18	18	18	18	18	18	0	0	18	18		18		18	18	18
Average	131.56	4174.56	2.43	1.50	0.59	0.50	0.49	0.00	0.00	5.51	757.44		1730.00		54.11	26.50	212.17
Desv.Est	40.07	542.40	0.17	0.00	0.22	0.00	0.05	0.00	0.00	0.05	98.10		0.00		48.65	13.12	62.63
C.Var.	30.46	12.99	7.04	0.00	37.2	0.00	9.64	0.00	0	0.86	12.95		0.00		89.90	49.51	29.52
Δ	3.73	508.97	-0.07	0.00	0.09	0.0	-0.01	0.00	0.00	0.01	90.97		0.00		17.76	7.50	28.99
t	0.31	2.92								1.00	2.88				1.53	2.01	1.71
°L	34	35								17	35				18	31	28

Table. 10
COMPARISON OF MELTINGS SHIFT W-1 vs MELTINGS SHIFT W-2

Furnace	W-1		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	49	49	49	49	48	48	48	1	0	49	49		49		49	49	49
Average	141.92	3898.78	2.42	1.54	0.57	0.50	0.5	1.40	0.00	5.53	705.18		1730.00		34.69	21.88	198.49
Desv.Est	38.05	506.40	0.20	0.29	0.18	0.00	0	0.00	0.00	0.15	89.72		0.00		8.29	20.33	52.74
C.Var.	26.81	12.99	8.26	18.54	31.1	0.00	0	0.00	0	2.66	12.72		0.00		23.89	92.94	26.57

Furnace	W-2		Type of load							Total	Energetic	Type of	Unload	Batch	Type of Delay		
Date	Time	Consum.	1	2	3	4	5	6	7	Load	Index	Steel	Temperature	Worker	Col-Col	Maintenance	Gross time
Data	41	41	41	41	41	41	41	0	0	41	41		41		41	41	41
Average	120.02	3854.68	2.44	1.50	0.54	0.50	0.5	0.00	0.00	5.48	703.15		1730.00		41.85	47.00	208.88
Desv.Est	31.29	447.90	0.15	0.00	0.13	0.00	0	0.00	0.00	0.11	78.77		0.00		7.54	47.06	62.59
C.Var.	26.07	11.62	6.34	0.00	24.6	0.00	0	0.00	0	2.09	11.20		0.00		18.02	100.13	29.96
Δ	-21.89	-44.09	0.03	-0.04	-0.04	0.0	0.00	-1.40	0.00	-0.05	-2.02		0.00		7.16	25.12	10.39
t	3.00	0.44								1.74	0.11				4.29	3.18	0.84
°L	90	90								89	90				89	53	80

7.- GENERAL CONCLUSIONS Y RECOMMENDATIONS

7.1 IMPROVE LOAD FACTOR FOR FUMOSA IN GENERAL

Load Factor is defined as the demand quoefficient measured between maximum demand and can be calculated based on the values registered in the electric energy bill according to the following formulas:

LOAD FACTOR = MEDIUM DEMAND / MAXIMUM DEMAND

MEDIUM DEMAND= Registered kWh / Period Hours

$$\text{LOAD FACTOR} = \frac{\text{Registered kWh}}{(\text{MAXIMUM MEDIUM DEMAND})\,(\text{PERIOD HOURS})}$$

This is, load factor relate the energy used during the billed period in respect to energy the supplier (CFE) can supply relative to the maximum demand during the same period.

If the user consumes the total capacity, or maximum demand, 24 hours daily, it is said to be operating at 100% capacity or his the load factor.
This is the way to get the lowest tariff per kilowatt-hour

However, if the operation of the plant decreases, the charges for demand are spread among a few kilowatts-hour and thus the charges go up for each kilowatt-hour.

The new disposition is that the consumers that present high load factors promote a higher in using their installations. so it is a good advise to stimulate such behavior and so it is pertinent to affix special tariffs for those medium and high power users (FUMOSA's case) to promote said factor.

Analyzing the demand curves we can determinate when maximum demand occur and the reasons for the same and then we can be prepared to take appropriate actions, the importance that the PLC that FUMOSA already has will be very important for said demand curve analysis.

Some of the measures to improve load factor can be :

1. Prevent when possible the simultaneous startup of equipment and electric loads whose starting power are high (as induction furnaces, arc furnaces, cooling systems air compressors etc.)
2. Establish an equipment operation program that will allow to separate the fusion and steel installations without affecting production .
3. Install an automatic control system or reprogram the one in place, to supervise demand behavior and to make the disconnection or load limitation as to the program pre-established according to FUMOSA's functions.

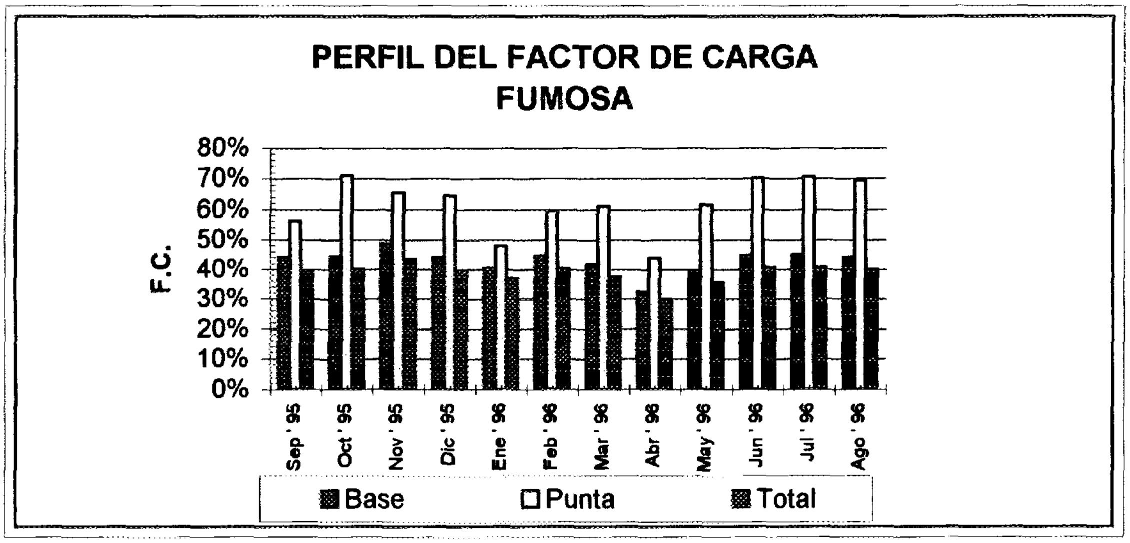
The automatic demand control should be considered when the demand is to variable and control can be feasible due to existing controllable loads. This type of control has been widely used in the steel industry with excellent results the second step is to identify controllable loads, which could be de-energized to get the desired limit.

For FUMOSA *in this year it has had a load factor of 38.63% so kilowatt-hour average cost* is $ 0.3108 aprox. As this factor is increased the benefits will be for decrease in kilowatt-hour cost which makes implementation of these programs and measures indispensable to favor this index increase.

The following charts show the relationship between medium cost of each kilowatt-hour against load factor percentage

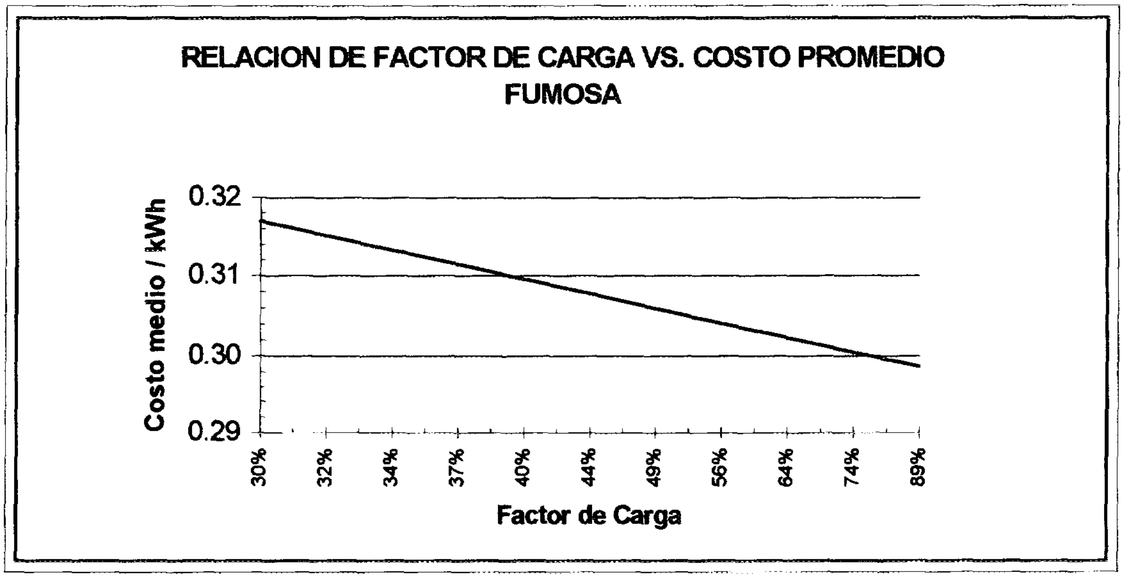
FACTOR DE CARGA GENERAL
FUMOSA

Período	Consumo			Demanda			Factor de carga		
	Base	Punta	Total	Base	Punta	Fact.	Base	Punta	Total
Sep ' 95	2,935,603	241,675	3,177,278	11,121	3,994	5,419	43.99%	56.03%	39.68%
Oct ' 95	3,152,955	274,929	3,427,884	11,490	3,595	5,174	44.26%	70.81%	40.10%
Nov ' 95	3,385,943	249,469	3,635,412	11,613	3,533	5,149	48.59%	65.38%	43.48%
Dic ' 95	3,200,425	251,482	3,451,907	11,736	3,625	5,247	43.98%	64.24%	39.53%
Ene ' 96	2,749,693	258,140	3,007,833	10,988	4,997	6,195	40.36%	47.83%	36.79%
Feb ' 96	2,853,320	232,850	3,086,170	11,050	3,625	5,110	44.52%	59.48%	40.13%
Mar ' 96	3,114,425	236,522	3,350,947	12,043	3,595	5,285	41.71%	60.92%	37.40%
Abr ' 96	2,153,795	219,617	2,373,412	11,060	4,639	5,923	32.46%	43.83%	29.80%
May ' 96	3,005,676	239,985	3,245,661	12,258	3,625	5,352	39.55%	61.30%	35.59%
Jun ' 96	3,126,336	274,507	3,400,843	11,643	3,623	5,227	44.75%	70.16%	40.57%
Jul ' 96	3,405,189	297,170	3,702,359	12,258	3,902	5,573	44.81%	70.52%	40.60%
Ago ' 96	3,484,930	302,736	3,787,666	12,749	4,056	5,795	44.09%	69.11%	39.93%



RELACION DE FACTOR DE CARGA VS. COSTO PROMEDIO DE ENERGIA FUMOSA

Demanda			Consumo			F.B.M.	Factor de Carga	Costo/kWh
Base	Punta	Fact.	Base	Punta	Total			
15,000	4,000	6,200	3,050,000	260,000	3,310,000	1,048,939	0.30	0.3169
14,000	4,000	6,000	3,050,000	260,000	3,310,000	1,042,858	0.32	0.3151
13,000	4,000	5,800	3,050,000	260,000	3,310,000	1,036,778	0.34	0.3132
12,000	4,000	5,600	3,050,000	260,000	3,310,000	1,030,698	0.37	0.3114
11,000	4,000	5,400	3,050,000	260,000	3,310,000	1,024,618	0.40	0.3096
10,000	4,000	5,200	3,050,000	260,000	3,310,000	1,018,538	0.44	0.3077
9,000	4,000	5,000	3,050,000	260,000	3,310,000	1,012,457	0.49	0.3059
8,000	4,000	4,800	3,050,000	260,000	3,310,000	1,006,377	0.56	0.3040
7,000	4,000	4,600	3,050,000	260,000	3,310,000	1,000,297	0.64	0.3022
6,000	4,000	4,400	3,050,000	260,000	3,310,000	994,217	0.74	0.3004
5,000	4,000	4,200	3,050,000	260,000	3,310,000	988,137	0.89	0.2985



7.2 EFFECTIVE CONTROL OF LOADS, WEIGHT, QUALITY AND TYPE OF RAW MATERIAL FOR MELTING

Within the DEN-2 performed at FUMOSA, one of the biggest opportunity areas with higher impact in operative function as well as furnace loading and pouring methods.

For this last one we could detect a series of procedure anomalies in operation practices when the arc furnaces were loaded , with the result that energy consumption by the load suffers great variations and consequently increases costs in electric energy

First the process starts with scrap selection to be placed in hoppers to be melted later some of the deficiencies we found are :

- There is no reliable weight measure
- There is no kind of report or analysis that certifies scrap quality (%Fe) loaded into the furnace
- The size, shape, density and supply is not standard, so a lot of variations occur in energy consumption
- Scrap patios are not identified according to type of scrap (1.st, 2,nd. 3, rd, etc)

After being loaded in to hoppers, these are transported into the building with a transfer car, which works as hopper support, while the melt process starts.

The melting process lasts 100 to 120 minutes, during this process another problem that occurs frequently is lack of effective measurement of reloads and alloys made during the melt, this mainly due to lack of scales, thermometers, lack of attention etc.

What we propose in general is to develop a project to standardize procedures and a logistics system to handle materials at FUMOSA

From the results obtained from such analysis we expect the following benefits:

- Accounting
- Financial
- Process
- Better consumable control (raw material, electric energy, natural gas, etc.)
- Initial Phase for ISO 900 Certification

8.- ANNEXES

TARIFA HM
TARIFA HORARIA PARA SERVICIO GENERAL A MEDIA TENSION

TENSION DE SUMINISTRO: De 1kV hasta 35 kv

LIMITE DE CARGA: Para usuarios con carga superior a 1,000 kW

PARAMETROS DE FACTURACIÓN:

DEMANDA FACTURABLE: Es la que resulte de aplicar la siguiente formula:

kWDem. Facturable = kWDem. Punta+1/5*(Diferencia de Demandas)

Diferencia de Demandas = kWDem.Base - kWDem.Punta

CONSUMO DE ENERGIA FACTURABLE:

Se determina el consumo de energía en período de punta.

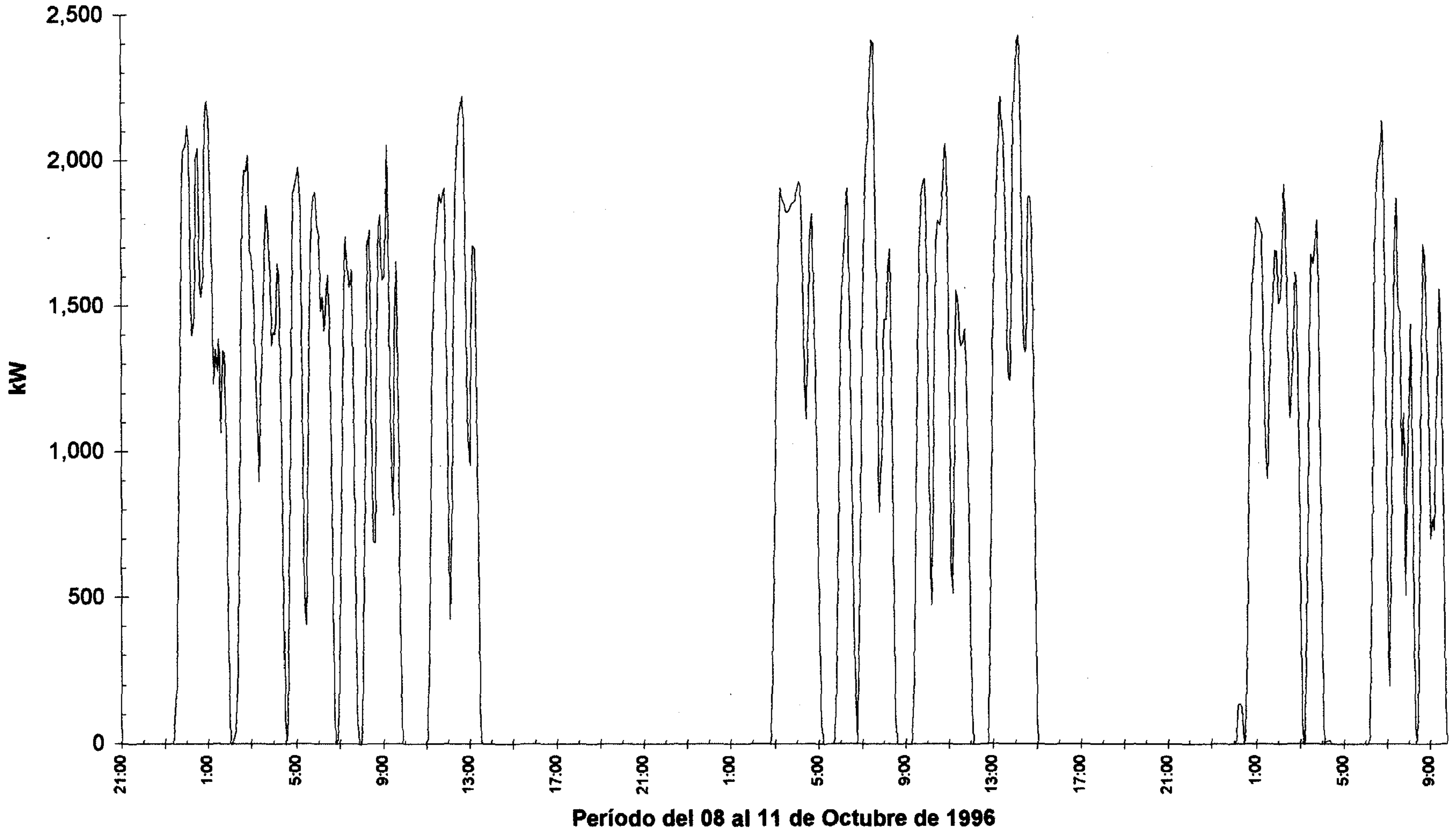
Se determina el consumo de energía en período de base.

CUOTAS APLICABLES MENSUALES PARA LA REGION NORESTE EN 1996:

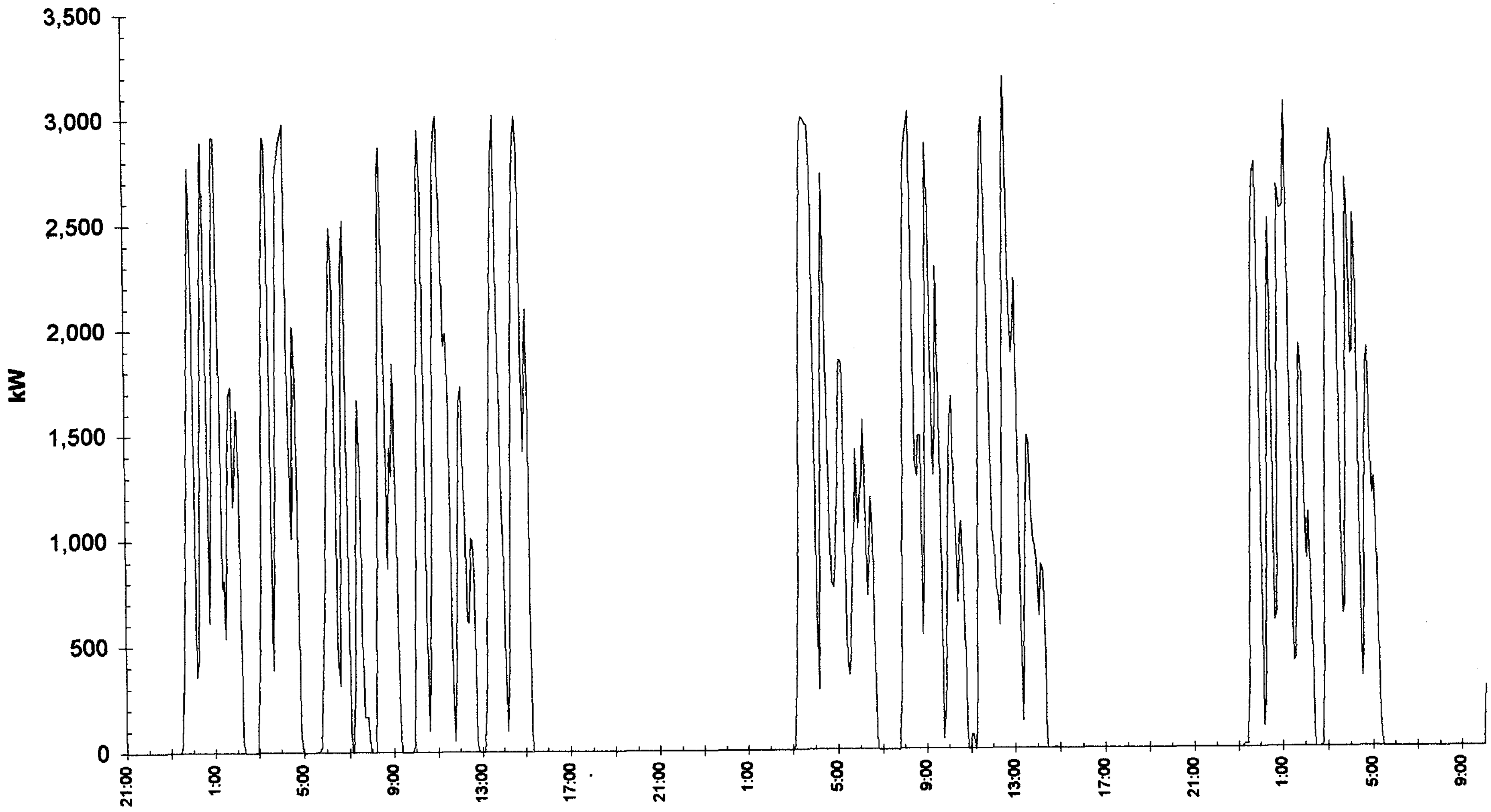
MES	CARGO POR kW DEMANDA MAXIMA $ M.N.	CARGO POR kWh DE PUNTA $ M.N.	CARGO POR kWh DE BASE $ M.N.
1-18 Diciembre	23.432	0.19534	0.12209
19-31 Diciembre	25.775	0.21487	0.13430
Enero	26.084	0.21745	0.13591
Febrero	26.397	0.22006	0.13754
Marzo	26.714	0.22270	0.13919
Abril	28.985	0.24163	0.15102
Mayo	29.333	0.24453	0.15283
Junio	29.685	0.24746	0.15466
Julio	30.041	0.25043	0.15652
Agosto	30.401	0.25344	0.15840
Septiembre	30.766	0.25648	0.16030
Octubre	31.135	0.25956	0.16222
Noviembre	31.509	0.26267	0.16417
Diciembre	31.887	0.26267	0.16417

MINIMO MENSUAL: Es el que resulte de aplicar 10 veces el cargo por kilowatt de demanda máxima medida.

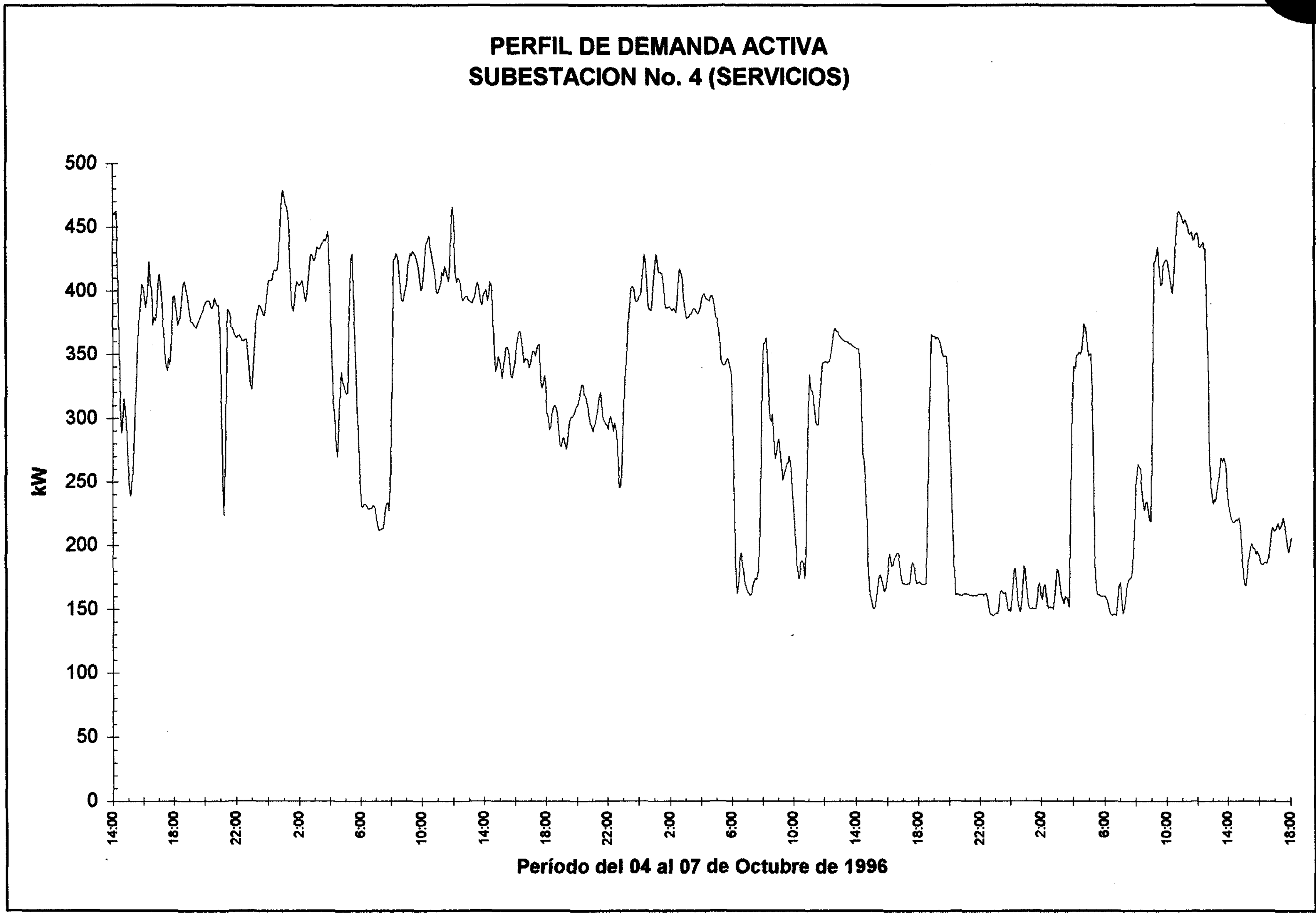
PERFIL DE DEMANDA ACTIVA
HORNO WHITING No. 1



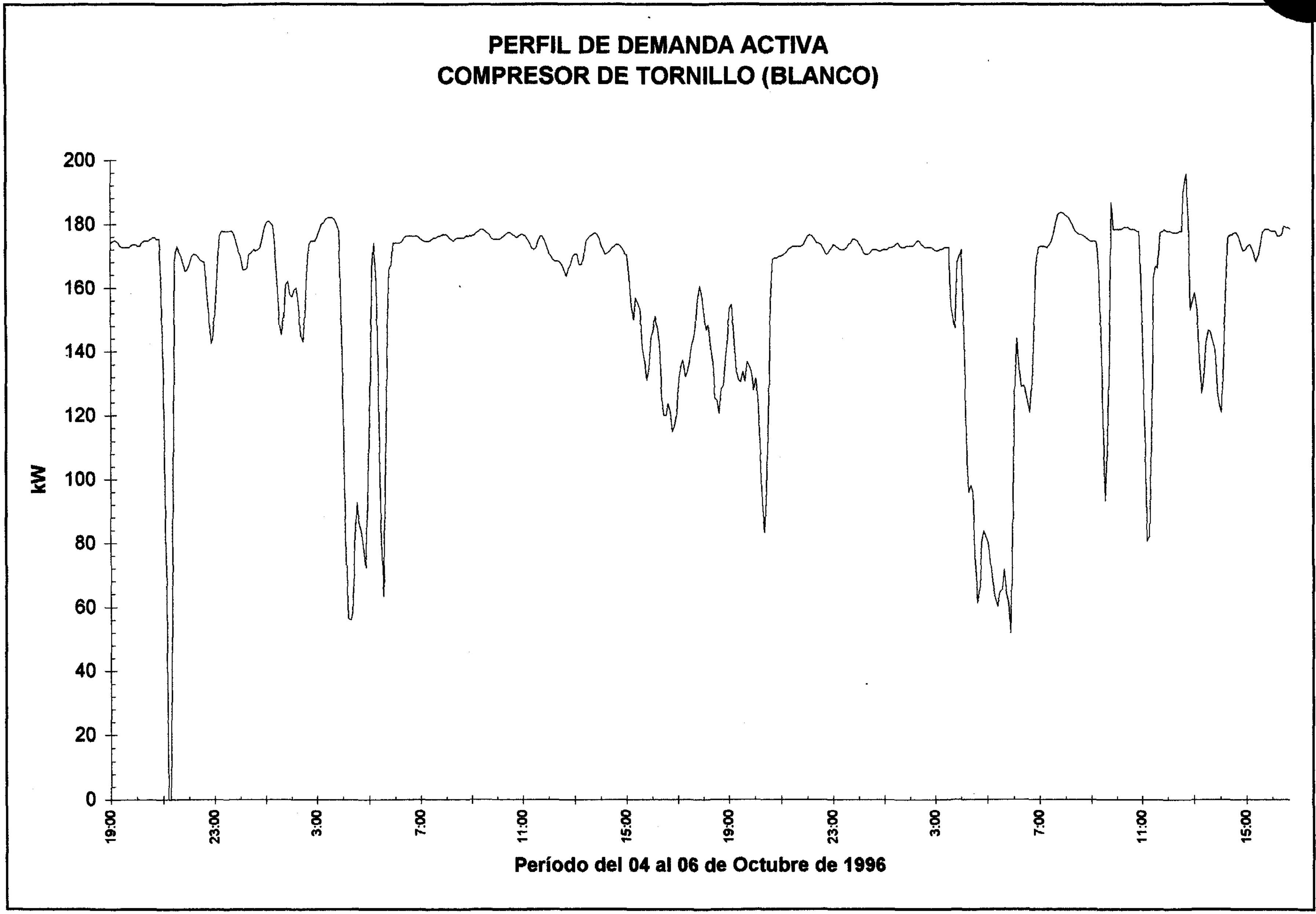
PERFIL DE DEMANDA ACTIVA
HORNO WHITING No. 2

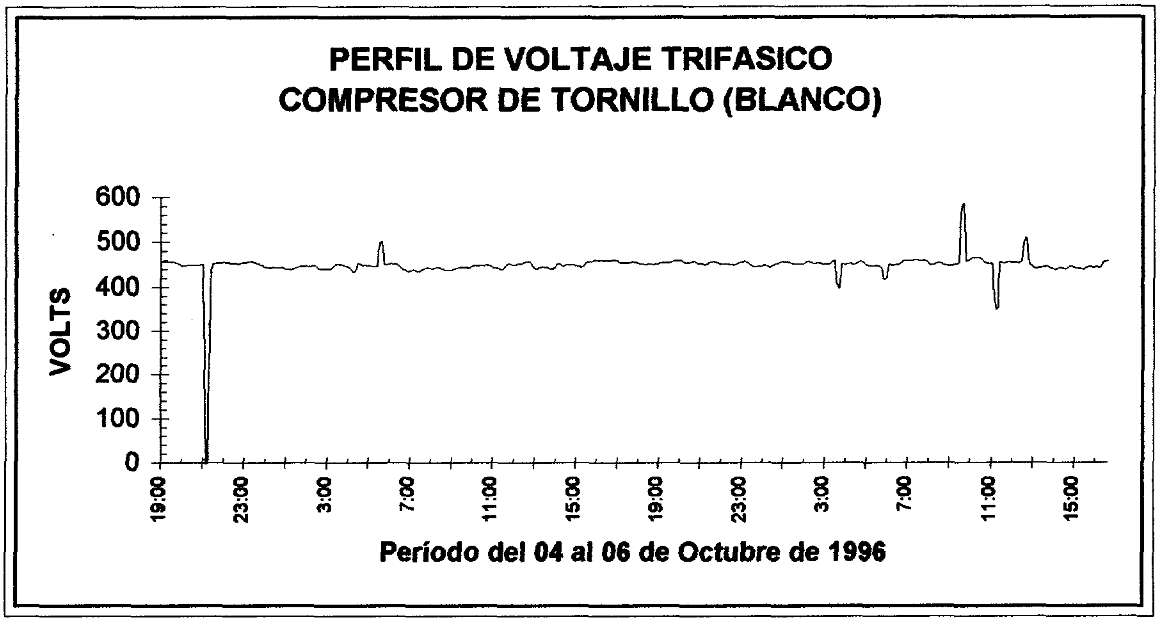


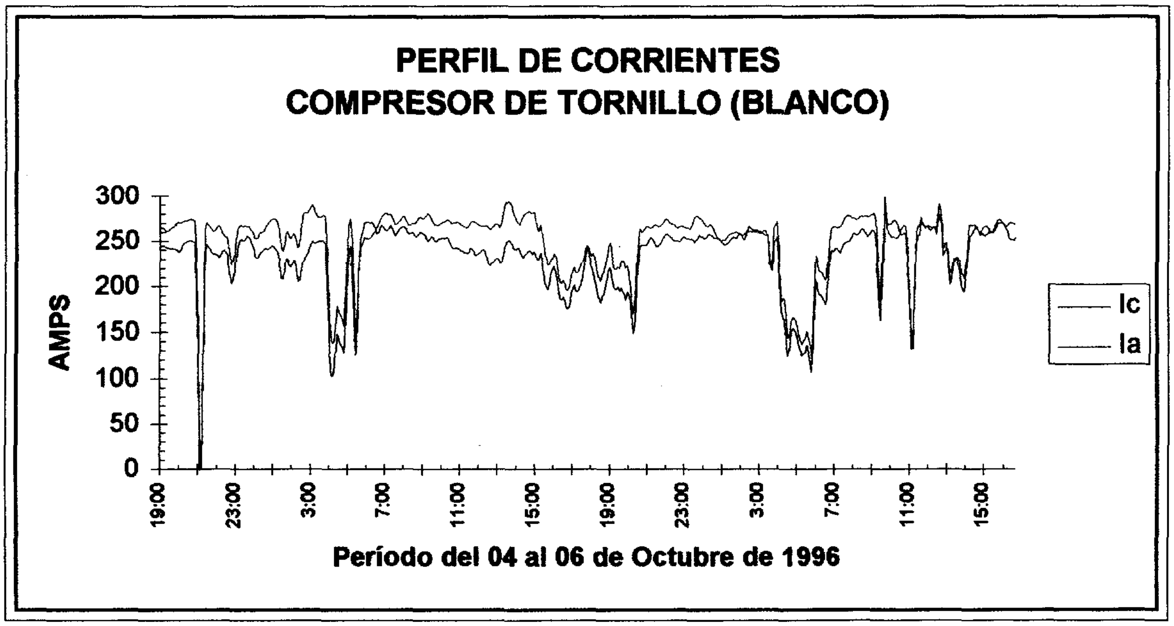
Período del 08 al 11 de Octubre de 1996



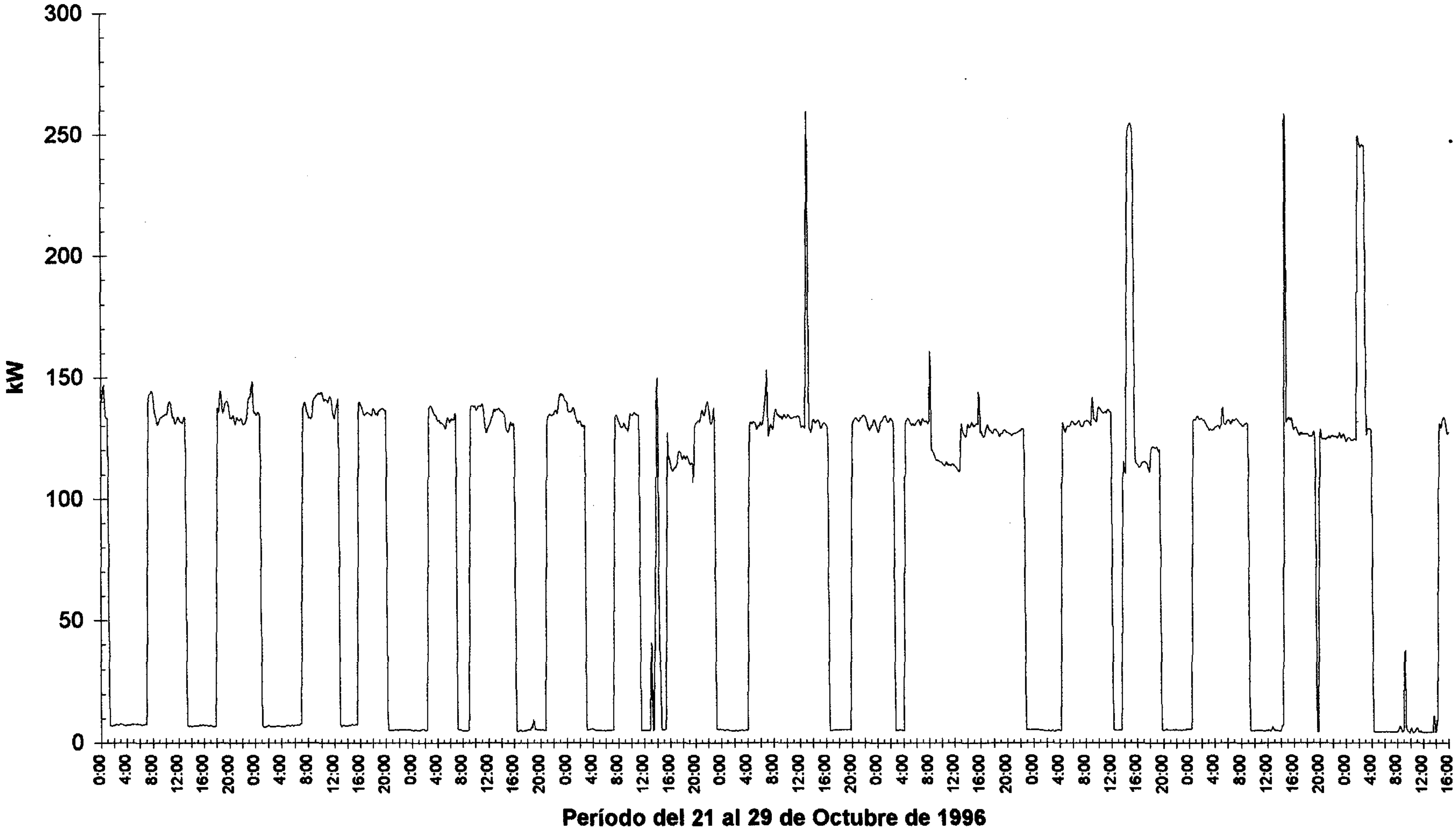
PERFIL DE DEMANDA ACTIVA
SUBESTACION No. 4 (SERVICIOS)
kW
500
450
400
350
300
250
200
150
100
50
0
14:00
18:00
22:00
2:00
6:00
10:00
14:00
18:00
22:00
2:00
6:00
10:00
14:00
18:00
22:00
2:00
6:00
10:00
14:00
18:00
Período del 04 al 07 de Octubre de 1996


PERFIL DE DEMANDA ACTIVA
COMPRESOR DE TORNILLO (BLANCO)
kW
200
180
160
140
120
100
80
60
40
20
0
19:00
23:00
3:00
7:00
11:00
15:00
19:00
23:00
3:00
7:00
11:00
15:00
Período del 04 al 06 de Octubre de 1996


PERFIL DE VOLTAJE TRIFASICO
COMPRESOR DE TORNILLO (BLANCO)
600
500
400
300
200
100
0
VOLTS
19:00
23:00
3:00
7:00
11:00
15:00
19:00
23:00
3:00
7:00
11:00
15:00
Período del 04 al 06 de Octubre de 1996


PERFIL DE CORRIENTES
COMPRESOR DE TORNILLO (BLANCO)
300
250
200
150
100
50
0
AMPS
19:00
23:00
3:00
7:00
11:00
15:00
19:00
23:00
3:00
7:00
11:00
15:00
Ic
Ia
Período del 04 al 06 de Octubre de 1996

PERFIL DE DEMANDA ACTIVA
COMPRESORES DE PALETAS RADIALES 1 Y 4



Parámetros de Operación en los Hornos de Tratamiento Térmico.

Parámetro	Templado 1	Templado 2	Templado 3	Revenido 1	Revenido 2
O_2, %V	9.3	8.4	2.7	13.4	18.5
CO_2, %V	6.3	6.9	9.6	4.2	1.3
CO, ppm	115	40	175	0	786
Datos medidos y calculados a condiciones reales					
Temp, °C	470	640	806	416	240
% exc.aire	82	64.4	22.7	167	510.7
% ef, P.C.I.	75	67.4	68.1	68.8	42.6
Costo, $/hr	29.48	32.82	32.48	21.42	34.62
Datos estandares de máxima eficiencia					
Temp, °C	180	180	180	180	180
% exc.aire	9.6	9.6	9.6	9.6	9.6
% ef, P.C.I.	94.7	94.7	94.7	94.7	94.7
Costo, $/hr	23.36	23.36	23.36	15.58	15.58
Beneficios esperados por corrección de deficiencias					
Operación,h/mes	620	620	620	580	580
Ahorro, $/mes	3,794	5,865	5,654	3,387	11,043

Ahorro total, $/mes 29,744

ANALISIS ENERGETICO DE UN PROCESO DE COMBUSTION

Fundición Monclova S.A. de C.V.

Datos Generales

Equipo monitoreado :	*Horno de templado No 1*
Fecha del análisis :	*10-Oct-96*
Combustible :	*Gas Natural*

a) Balance másico de la combustión.

Base de cálculo: 100 kg

Entradas.

1.- Composición elemental del combustible.

	%W	*kg*	*kmol*
C	71.77	71.77	5.98
H	22.56	22.56	22.38
O	1.78	1.78	0.11
N	3.89	3.89	0.28
H_2O	0.00	0.00	0.00
Ceniza	0.00	0.00	
	100.00	100.00	28.75

2.- Composición elemental del aire

	%V	*kmol*	*kg*
O_2	21	21.24	679.66
N_2	79	79.90	2238.38
		101.14	2918.04

3.- Humedad del aire

	%	*kmol*	*kg*
HR	80	4.00	71.98
Temp	30 °C	105.14	2990.02
P_{H2O}	4786	Pascales	

Total de Entradas 3090 kg

Salidas

4.- Gases de escape

	%V	*kmol*	*kg*
O_2	9.3	8.80	281.74
CO_2	6.3	5.96	262.49
CxHx	0.0	0.00	0.00
CO_{ppm}	115	0.01	0.30
N_2	84.4	79.90	2238.38
		94.67	2782.91
H_2O		17.04	306.95
		111.71	3089.86

Total de Salidas 3090 kg

Error 0.01 %

EXCESO DE AIRE

O_2 Alim	21.24	kmol/100 kg Comb.
O_2 Esteq		
Gas Nat.	11.67	kmol/100 kg GN
Gas L.P.		kmol/100 kg Gas L.P.
Fuel Oil	9.73	kmol/100kg Fuel Oil
Diesel	10.09	kmol/100kg Diesel

% en Exceso de Aire **82.0 %**

O_2 Esteq	11.67

b) Calor sensible en los gases de escape.

Temp de escape	470	°C
Temp del aire	30	°C
Flujo molar de gases	111.71	kmol
Capacidad calorífica	7.28	kcal/kmol °C
Pa	**357,816**	**kCal/100 kg de Comb**

c) Pérdida por combustión incompleta.

Poder calorífico de los inquemados

CH_4	200,000	kcal/kmol
CO	68,000	kcal/kmol

Flujo de componentes

CH_4	0.00	kmol
CO	0.01	kmol
Pb	**740**	**kCal/100 kg de Comb**

d) Energía aportada por el combustible.

PCI del Combustible

Gas Natural	14,352	kcal/kg	8,640 kcal/m3
Gas L.P.	10,296	kcal/kg	
Combustoleo	9,550	kcal/kg	
Diesel	10,000	kcal/kg	

P.C.I.	14,352	**H comb**	**1,435,200 kCal/100 kg de comb**

e) Tabla de Resumen

Concepto	kcal/kg Com	%
Calor sensible en humos	3,578	24.9
Combustión incompleta	7	0.1
Calor útil y eficiencia	10,766	75.0
Energía de combustión	14,352	100.0

ANALISIS ENERGETICO DE UN PROCESO DE COMBUSTION

Fundición Monclova S.A. de C.V.

Datos Generales

Equipo monitoreado :	*Horno de templado No 2*
Fecha del analisis :	*10-Oct-96*
Combustible :	*Gas Natural*

a) Balance másico de la combustión.

Base de cálculo: 100 kg

Entradas.

1.- Composición elemental del combustible.

	%W	*kg*	*kmol*
C	71.77	71.77	5.98
H	22.56	22.56	22.38
O	1.78	1.78	0.11
N	3.89	3.89	0.28
H_2O	0.00	0.00	0.00
Ceniza	0.00	0.00	
	100.00	100.00	28.75

2.- Composición elemental del aire

	%V	*kmol*	*kg*
O_2	21	19.19	613.92
N_2	79	72.17	2021.85
		91.36	2635.76

3.- Humedad del aire

	%	*kmol*	*kg*
HR	80	3.61	65.02
Temp	30 °C	94.97	2700.78
P_{H2O}	4786	Pascales	

Total de Entradas 2801 kg

Salidas

4.- Gases de escape

	%V	*kmol*	*kg*
O_2	8.4	7.17	229.31
CO_2	6.9	5.89	259.07
CxHx	0.1	0.09	1.37
CO_{ppm}	40	0.00	0.10
N_2	84.6	72.17	2021.85
		85.31	2511.69
H_2O		15.98	287.93
		101.29	2799.61

Total de Salidas 2800 kg

Error 0.04 %

EXCESO DE AIRE

O_2 Alim	19.19	kmol/100 kg Comb.
O_2 Esteq		
Gas Nat.	11.67	kmol/100 kg GN
Gas L.P.		kmol/100 kg Gas L.P.
Fuel Oil	9.73	kmol/100kg Fuel Oil
Diesel	10.09	kmol/100kg Diesel

% en Exceso de Aire 64.4 %

O_2 Esteq	11.67

b) Calor sensible en los gases de escape.

Temp de escape	640	°C
Temp del aire	30	°C
Flujo molar de gases	101.29	kmol
Capacidad calorifica	7.29	kcal/kmol °C
Pa	**458,672**	**kCal/100 kg de Comb**

c) Pérdida por combustión incompleta.

Poder calorífico de los inquemados

CH_4	200,000	kcal/kmol
CO	68,000	kcal/kmol

Flujo de componentes

CH_4	0.09	kmol
CO	0.00	kmol
Pb	**17,295**	**kCal/100 kg de Comb**

d) Energía aportada por el combustible.

PCI del Combustible

Gas Natural	14,352	kcal/kg	8,640 kcal/m³
Gas L.P.	10,296	kcal/kg	
Combustoleo	9,550	kcal/kg	
Diesel	10,000	kcal/kg	
P.C.I.	14,352	**H comb**	**1,435,200 kCal/100 kg de comb**

e) Tabla de Resumen

Concepto	kcal/kg Com	%
Calor sensible en humos	4,507	31.4
Combustión incompleta	173	1.2
Calor útil y eficiencia	9,672	67.4
Energía de combustión	14,352	100.0

ANALISIS ENERGETICO DE UN PROCESO DE COMBUSTION

Fundición Monclova S.A. de C.V.

Datos Generales

Equipo monitoreado :	*Horno de [illegible] No 3*
Fecha del analisis :	*10-Oct-96*
Combustible :	*Gas Natural*

a) Balance másico de la combustión.

Base de cálculo: 100 kg

Entradas.

1.- Composición elemental del combustible.

	%W	*kg*	*kmol*
C	71.77	71.77	5.98
H	22.56	22.56	22.38
O	1.78	1.78	0.11
N	3.89	3.89	0.28
H_2O	0.00	0.00	0.00
Ceniza	0.00	0.00	
	100.00	100.00	28.75

2.- Composición elemental del aire

	%V	*kmol*	*kg*
O_2	21	14.32	458.18
N_2	79	53.87	1508.94
		68.18	1967.12

3.- Humedad del aire

	%	*kmol*	*kg*
HR	80	2.69	48.52
Temp	30 ºC	70.88	2015.64
P_{H2O}	4786	Pascales	

Total de Entradas 2116 kg

Salidas

4.- Gases de escape

	%V	*kmol*	*kg*
O_2	2.7	1.66	53.13
CO_2	9.6	5.90	259.79
CxHx	0.1	0.06	0.99
CO_{ppm}	175	0.01	0.3[illegible]
N_2	87.6	53.87	1508.94
		61.49	1823.15
H_2O		16.30	293.73
		77.79	2116.88

Total de Salidas 2117 kg

Error -0.06 %

EXCESO DE AIRE

O_2 Alim	14.32	kmol/100 kg Comb.
O_2 Esteq		
Gas Nat.	11.67	kmol/100 kg GN
Gas L.P.		kmol/100 kg Gas L.P.
Fuel Oil	9.73	kmol/100kg Fuel Oil
Diesel	10.09	kmol/100kg Diesel

% en Exceso de Aire **22.7 %**

O_2 Esteq	11.67

b) Calor sensible en los gases de escape.

Temp de escape	806	°C
Temp del aire	30	°C
Flujo molar de gases	77.79	kmol
Capacidad calorífica	7.37	kcal/kmol °C
Pa	**444,748**	**kCal/100 kg de Comb**

c) Pérdida por combustión incompleta.

Poder calorífico de los inquemados

CH_4	200.000	kcal/kmol
CO	68.000	kcal/kmol

Flujo de componentes

CH_4	0.06	kmol
CO	0.01	kmol
Pb	**13,030**	**kCal/100 kg de Comb**

d) Energía aportada por el combustible.

PCI del Combustible

Gas Natural	14,352	kcal/kg	8,640	kcal/m3
Gas L.P.	10,296	kcal/kg		
Combustoleo	9,550	kcal/kg		
Diesel	10,000	kcal/kg		
P.C.I. 14,352	**H comb**		**1,435,200**	**kCal/100 kg de comb**

e) Tabla de Resumen

Concepto	kcal/kg Com	%
Calor sensible en humos	4,447	31.0
Combustión incompleta	130	0.9
Calor útil y eficiencia	9,774	68.1
Energía de combustión	14,352	100.0

ANALISIS ENERGETICO DE UN PROCESO DE COMBUSTION

Fundición Monclova S.A. de C.V.

Datos Generales

Equipo monitoreado :	*Horno de revenido No 1*
Fecha del análisis :	*10-Oct-96*
Combustible :	*Gas Natural*

a) Balance másico de la combustión.

Base de cálculo 100 kg

Entradas.

1.- Composición elemental del combustible.

	%W	*kg*	*kmol*
C	71.77	71.77	5.98
H	22.56	22.56	22.38
O	1.78	1.78	0.11
N	3.89	3.89	0.28
H_2O	0.00	0.00	0.00
Ceniza	0.00	0.00	
	100.00	100.00	28.75

2.- Composición elemental del aire

	%V	*kmol*	*kg*
O_2	21	31.16	997.15
N_2	79	117.23	3283.99
		148.39	4281.15

3.- Humedad del aire

	%	*kmol*	*kg*
HR	80	5.86	105.60
Temp	30 °C	154.25	4386.75
P_{H2O}	4786	Pascales	

Total de Entradas 4487 kg

Salidas

4.- Gases de escape

	%V	*kmol*	*kg*
O_2	13.4	19.06	610.02
CO_2	4.2	5.98	262.97
CxHx	0.0	0.00	0.00
CO $_{ppm}$	0	0.00	0.00
N_2	82.4	117.23	3283.99
		142.27	4156.99
H_2O		18.22	328.22
		160.49	4485.21

Total de Salidas 4485 kg

Error 0.03 %

EXCESO DE AIRE

O_2 Alim	31.16	kmol/100 kg Comb.
O_2 Esteq		
Gas Nat.	11.67	kmol/100 kg GN
Gas L.P.		kmol/100 kg Gas L.P.
Fuel Oil	9.73	kmol/100kg Fuel Oil
Diesel	10.09	kmol/100kg Diesel

% en Exceso de Aire **167.0 %**

O_2 Esteq	11.67

b) Calor sensible en los gases de escape.

Temp de escape	416	°C
Temp del aire	30	°C
Flujo molar de gases	160.49	kmol
Capacidad calorífica	7.22	kcal/kmol °C
Pa	**447.104**	**kCal/100 kg de Comb**

c) Pérdida por combustión incompleta.

Poder calorífico de los inquemados

CH_4	200,000	kcal/kmol
CO	68,000	kcal/kmol

Flujo de componentes

CH_4	0.00	kmol
CO	0.00	kmol
Pb	**0**	**kCal/100 kg de Comb**

d) Energía aportada por el combustible.

PCI del Combustible

Gas Natural	14,352	kcal/kg	8,640 kcal/m3
Gas L.P.	10,296	kcal/kg	
Combustoleo	9,550	kcal/kg	
Diesel	10,000	kcal/kg	
P.C.I.	14,352	**H comb**	**1,435,200 kCal/100 kg de comb**

e) Tabla de Resumen

Concepto	kcal/kg Com	%
Calor sensible en humos	4,471	31.2
Combustión incompleta	0	0.0
Calor útil y eficiencia	9,881	68.8
Energía de combustión	14,352	100.0

ANALISIS ENERGETICO DE UN PROCESO DE COMBUSTION

Fundición Monclova S.A. de C.V.

Datos Generales

Equipo monitoreado :	*Horno de revenido No 2*
Fecha del análisis :	*10-Oct-96*
Combustible :	*Gas Natural*

a) Balance másico de la combustión.

Base de cálculo: 100 kg

Entradas.

1.- Composición elemental del combustible.

	%W	*kg*	*kmol*
C	71.77	71.77	5.98
H	22.56	22.56	22.38
O	1.79	1.79	0.11
N	3.89	3.89	0.28
H_2O	0.00	0.00	0.00
Ceniza	0.00	0.00	
	100.00	100.00	28.75

2.- Composición elemental del aire

	%V	*kmol*	*kg*
O_2	21	71.26	2280.37
N_2	79	268.09	7510.08
		339.35	9790.45

3.- Humedad del aire

	%	*kmol*	*kg*
HR	80	13.41	241.50
Temp	30 °C	352.76	10031.94
P_{H2O}	4786	Pascales	

Total de Entradas 10132 kg

Salidas

4.- Gases de escape

	%V	*kmol*	*kg*
O_2	18.5	62.15	1988.77
CO_2	1.3	4.37	192.21
CxHx	0.4	1.34	21.56
CO $_{ppm}$	786	0.26	7.40
N_2	79.8	268.09	7510.08
		335.95	9720.02
H_2O		22.74	409.72
		358.70	10129.73

Total de Salidas 10130 kg

Error 0.02 %

EXCESO DE AIRE

O_2 Alim	71.26	kmol/100 kg Comb.
O_2 Esteq		
Gas Nat.	11.67	kmol/100 kg GN
Gas L.P.		kmol/100 kg Gas L.P.
Fuel Oil	9.73	kmol/100kg Fuel Oil
Diesel	10.09	kmol/100kg Diesel

% en Exceso de Aire **510.7 %**

O_2 Esteq	11.67

b) Calor sensible en los gases de escape.

Temp de escape		240 °C
Temp del aire		30 °C
Flujo molar de gases		358.70 kmol
Capacidad calorifica		7.13 kcal/kmol °C
	Pa	**537,279 kCal/100 kg de Comb**

c) Pérdida por combustión incompleta.

Poder calorifico de los inquemados

CH_4	200.000 kcal/kmol	
CO	68.000 kcal/kmol	
Flujo de componentes		
CH_4	1.34 kmol	
CO	0.26 kmol	
	Pb	**286,719 kCal/100 kg de Comb**

d) Energía aportada por el combustible.

PCI del Combustible

Gas Natural	14,352 kcal/kg		8,640 kcal/m3
Gas L.P	10,296 kcal/kg		
Combustoleo	9,550 kcal/kg		
Diesel	10.000 kcal/kg		
P.C.I.	14,352	**H comb**	**1,435,200 kCal/100 kg de comb**

e) Tabla de Resumen

Concepto	kcal/kg Com	%
Calor sensible en humos	5.373	37.4
Combustión incompleta	2.867	20.0
Calor útil y eficiencia	6.112	42.6
Energia de combustion	14,352	100.0