INCREASING THE PRODUCTION CAPACITY AT THE PELLETIZING PLANT IN SÃO LUÍS[1]

INCREASING THE PRODUCTION CAPACITY AT THE NORTHERN PELLETIZING PLANT

Liliane Durans de Moraes[2]
Lucas Guimarães Osório[3]
Clayton Francis dos Santos Nonato[4]
Flavio Barbosa do Nascimento[5]
Luciano Guido de Macedo[6]
Reinaldo Henrique Pedrini[3]
Gilmar Lucas Pereira[3]

Abstract

This work will show the actions that were developed to increase the production capacity at the Northern Pelletizing plant, located in São Luís, Maranhão, assuring the fulfillment of the contractual quality specifications of the product supplied to the clients. In addition to studies and the analysis of the best alternatives to ensure the economical feasibility of the project, in line with the highest demand of the steel market, the results obtained after the conclusion of all the investments are also mentioned. Increasing; Economical feasibility; Quality; Production.

Key words:

[1] *Technical contribution to the 2nd International Symposium on Iron Ore, September 22 – 26, 2008, São Luís City – Maranhão State – Brazil*

[2] *Operating Analyst, Companhia Vale do Rio Doce.*
[3] *Process Engineer, Companhia Vale do Rio Doce*
[4] *Operation Engineer, Companhia Vale do Rio Doce*
[5] *Operation Supervisor, Companhia Vale do Rio Doce*
[6] *General Manager, Companhia Vale do Rio Doce*

1 INTRODUCTION

There's an increasing demand for pellets the world over. To meet this demand, a detailed study was conducted for the existing limitations in Usina 1 Norte (U1N), located in São Luís, Maranhão. This study presents the assessments and actions taken to ensure the production increase of this unit without deterioration of the quality parameters of produced pellets.

2 MATERIAL AND METHODS

2.1 Process Flowchart

Usina 1 Norte process flowchart is shown below:

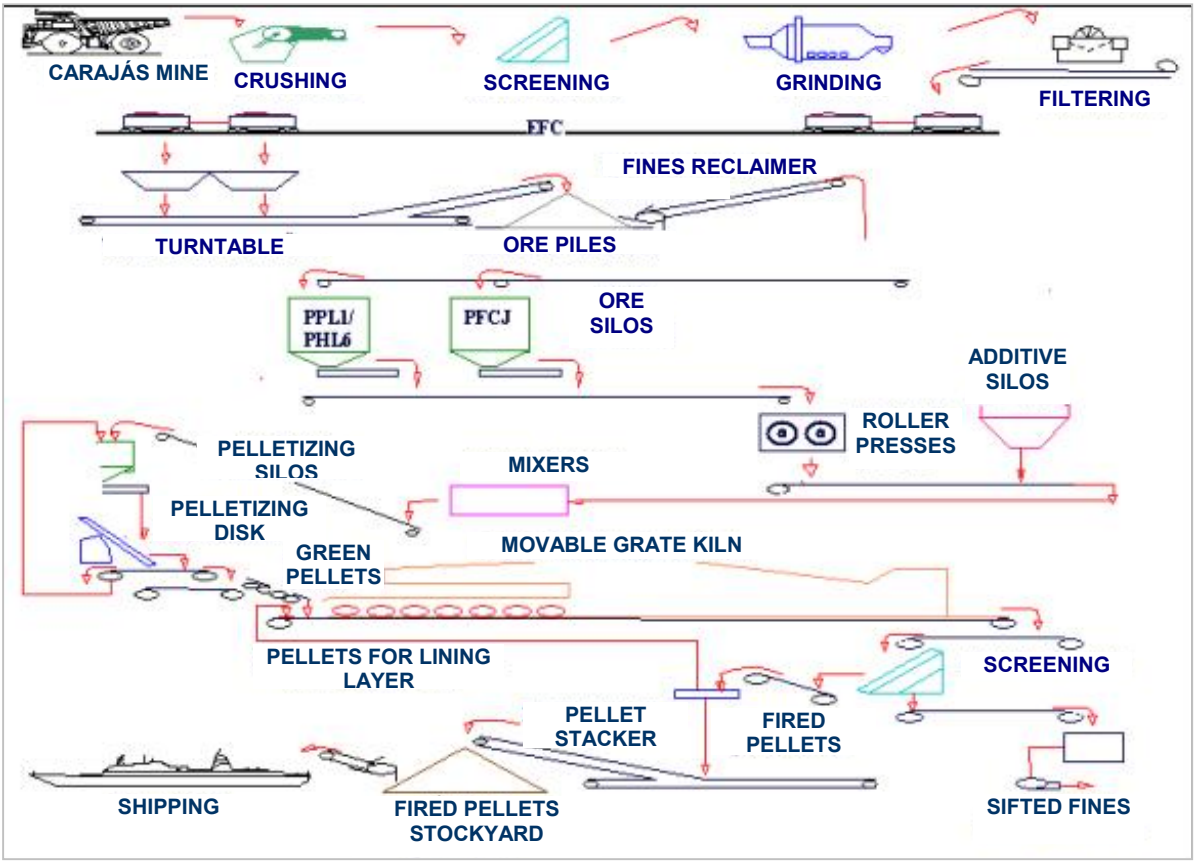


Figure 1: U1N process flowchart

2.2 Definition of Project Premises

The first step of the studies was related to defining the basic premises to be considered while developing the project.
The table below contains a summary of the primary technical premises.

Table 1: Premises for defining the expansion design for U1N, 2004.

Indicators		Original Design	Current	With Expansion
Grate Productivity	t/m²xday	23.67	23.65	**26.50**
Operating Yield	%	90.43	92.00	**94.30**
Daily Production	t/day	18, 179	18, 163	**20, 352**
Annual Production	t/year	6, 000, 000	6, 099, 203	**7, 005, 057**

Source: Project for production increase of U1N

This way, to reach a production of 7.0 Mt/year, it would be necessary to increase productivity by 12% and operating yield by 2.5% when compared to the plant's previously recorded indices.

2.3 Definition of Projects for Expanding the Capacity of U1N

A number of alternatives were identified to meet the established premises. Preferably, investments that would permit expansion to 7.0 Mt/year by increasing the Grate Productivity or Operating Yield should be considered.
Based on this criterion, the following investment needs were identified:

Table 2. Production lines assessment

Equipment/Phase	Productivity	Operating Yield
01 Pelletizing Disk	**High**	**Low**
02 Intermediate input silos	**High**	**High**
Increase of mixture lines capacity	**Medium**	**Medium**
Increase of process fans capacity	**High**	**Low**

Source: Project for increasing production of U1N

2.3.1 Justification of investments

- **Additional pelletizing disk**

As previously mentioned, U1N had originally been designed to produce 6.0 Mt/year and, for that, 10 pelletizing disks were considered. However, this number, according to the mass balance, proved itself insufficient for producing the additional volume of green pellets to feed the kiln in such a way to ensure the annual production of 7.0 Mt/year. It then became necessary to purchase one more pelletizing disk, in addition to its peripherals (feed silo, proportioning scale, roller sieve, conveyors and chutes), which would facilitate the following:

(1) Increase in equipment availability associated with green pellet formation stage of the pelletizing process;
(2) Optimization of the Plant's operation and maintenance conditions (greater operating flexibility);
(3) Assurance of the final product quality (pellets).

- Capacity: 160 ton/h (equal to current level)

• Estimated price: US$ 2, 140, 000.00

- **Intermediate input silos**

U1N has 5 (five) additive silos, each with a designed capacity of 200 m³. This storage capacity would allow the pelletizing Plant to operate for only 5 hours. Thus, two 1400 m³ silos were installed between input grinding and mixing stages.

The two new additive silos have increased the storage capacity of crushed input, thereby reducing possible losses of the pelletizing Plant in the event of input grinding stoppages.

• Capacity: 1400 m³

• Estimated price: US$ 5, 564, 000.00

- **Increasing of mixture lines capacity**

U1N has 2 (two) mixture lines with designed capacity of 466 t/h and 582 t/h, respectively. The mass balance has indicated the need to increase the capacity of the conveyor belt set, input dosage system, and mixers. Further assessments have identified 4 (four) belt sets that should have their capacity expanded, considering, as premise, a maximum filling value of 80%, with the following new results for the project capacity:

- TR-840K-01: 1997 t/h
- TR-840K-02: 1997 t/h
- TR-840K-03: 1997 t/h
- TR-851K-01: 1997 t/h

The capacity of each line was increased to 640 t/h, which is the maximum limit for the existing model of mixers according to the manufacturer.

• Capacity: 640 t/h

• Estimated price: US$ 2, 392, 000.00

- **Increasing of process fans capacity**

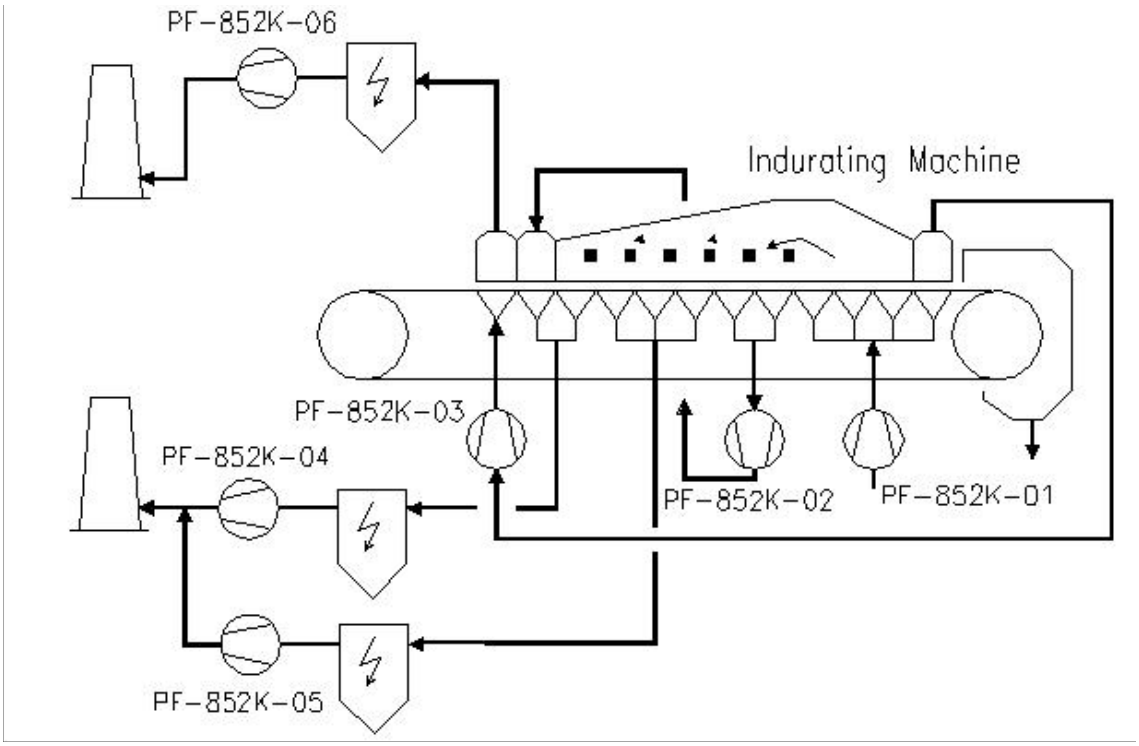


Figure 2: Flowchart of the U1N kiln

U1N has 6 process fans designed to work at a total pellet bed height equal to 400 mm. The proposed capacity increase required to raise the bed's height to 500 mm.
The process fans were then adjusted to the new operating condition.
Resizing the fans was an outstanding aspect of the capacity increasing process. In addition to the premises considered for ensuring productivity increase and operating yield, the following were defined to resize the fans:

- Maintenance of the current thermal cycle.
- Increase of green pellet layer in proportion to the desired increase in production.
- Increase of gas flow in proportion to the production increase.
- Increase of quadratic Δp in proportion to gas flow increase and linear with the increase of the layer's height.
- Maintenance of gases temperatures.

- Calculation of new gases outflow

(1) Estimate of the current maximum outflow:

$$Q_{7,0(real)} = \frac{W_{7,0(real)}}{W_{7,0(projeto)}} Q_{7,0(projeto)}$$

(2) Estimate of new required maximum outflow: $Q_{7.5}=Q_{7.0*}1.08$
(3) The fans input density and pressure were estimated by interpolation of data provided by Lurgi (7.0 Mt/year and 500 mm).
(4) Temperatures were maintained in accordance with Lurgi's data (the company contracted to prepare the implementation project of U1N).

- Calculation of the new Δp

(1) $\Delta p_{7.0}$ was obtained from the original Lurgi project
(2) $\Delta p_{7.5} = \Delta p_{7.0}*(1, 08)2*1, 065$
The $Q_{7.5}$ and $\Delta p_{7.5}$ data and the conditions of density, temperature, and static pressure were reported to Howden for sizing the fans.
After defining the parameters to be considered in resizing the process fans, the best ways to implement the changes in the fans operation system were analyzed, taking into account the frequency inverters (represented in diagram 1 as the electric control system for the process fans), engine, and rotor of each fan:

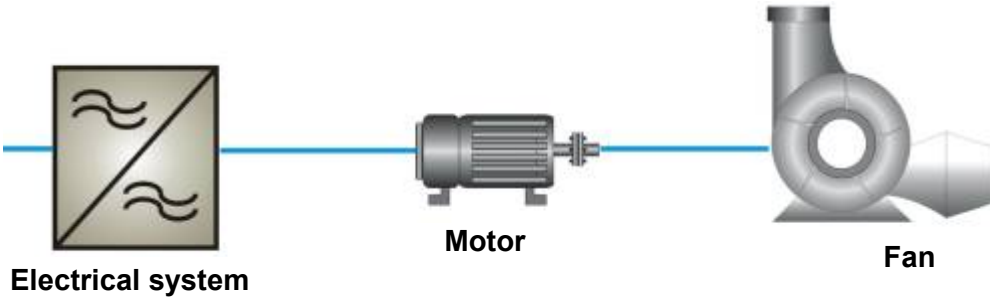


Figure 3: Diagram of the U1N process fan driving system

The following simulations were performed to identify the best investment alternative with regard to the fans:

- **Environmental Equipment**

Efficiency studies on the electrostatic precipitators and gas washers with the production increase were made and confirmed that it would not be necessary to increase the capacity of such equipment.

Table 3. Identified investment alternatives for increasing of production at U1N, 2004(1US$ = R$ 3, 15)

Alternative	PF-852K-01 (R$ M)	PF-852K-02 (R$ M)	PF-853K-03 (R$ M)	PF-852K-04 (R$ M)	PF-852K-05 (R$ M)	PF-852K-06 (R$ M)	Total (R$ M (*))	Total (US$ M (*))	Maximum Amount (+45%) (**) (US$ M)
1	8.0	3.5	0.3	5.0	0.0	3.5	20.3	6.4	9.3
2	**5.0**	**3.5**	**0.3**	**5.0**	**0.0**	**3.5**	**17.3**	**5.5**	**8.0**
3	0.0	3.5	0.3	5.0	0.0	3.5	12.3	3.9	5.7
4	8.0	3.5	0.3	1.5	0.0	3.5	16.8	5.3	7.7
5	5.0	3.5	0.3	1.5	0.0	3.5	13.8	4.4	6.4
6	0.0	3.5	0.3	1.5	0.0	3.5	8.8	2.8	4.1

(*) Precipitators not included (**) Imprecision
Source: Project for production increase of U1N

Alternative 2 (two) represents the following adjustments:

Table 4. Items identified for increasing of process fans capacity, 2004

Fan	Driver	Engine	Rotor
PF-852K-01	Replace	Replace	Keep
PF-852K-02	Increase capacity	Keep	Replace
PF-852K-03	Increase capacity	Keep	Replace
PF-852K-04	Replace	Replace	Keep
PF-852K-05	Keep	Keep	Keep
PF-852K-06	Increase capacity	Replace	Replace

Source: Project for production increase of U1N

2.4 Economic Feasibility Assessment

2.4.1 Economic premises

The following table contains the economic parameters considered in the economic feasibility analysis:

Table 5. Economic premises for production increase of U1N, 2004

CAPEX (US$ MM)	14.82
Imprecisions (US$ MM)	3.44
Increased CAPEX (US$ MM)	18.26
Investment in Working Capital (US$ MM)	1.14
Sale Price Blast Furnace Pellets (US$/ton)	41.10
Cost – Cash of production (for 2004) (US$/ton)	25.57
Margin (for 2004) (US$/ton)	15.53
Δ of Dry Base Capacity (Mt/year)	0.90

In addition to the premises, the production increase would be based on blast furnace pellets. The total investment in capacity expansion was US$ 18,260,000.00 (Table 6).

Table 6. Investment needed for production increase of U1N, 2004

Capital investment	Increased investment value		
(US$MM)	2004	2005	Total
Intermediate input silos	0.14	5.43	**5.56**
Pelletizing disk	0.07	2.07	**2.14**
Increase of fans capacity	0.08	8.08	**8.16**
Increase of mixture lines	0.07	2.32	**2.39**
Total	0.36	17.90	**18.26**

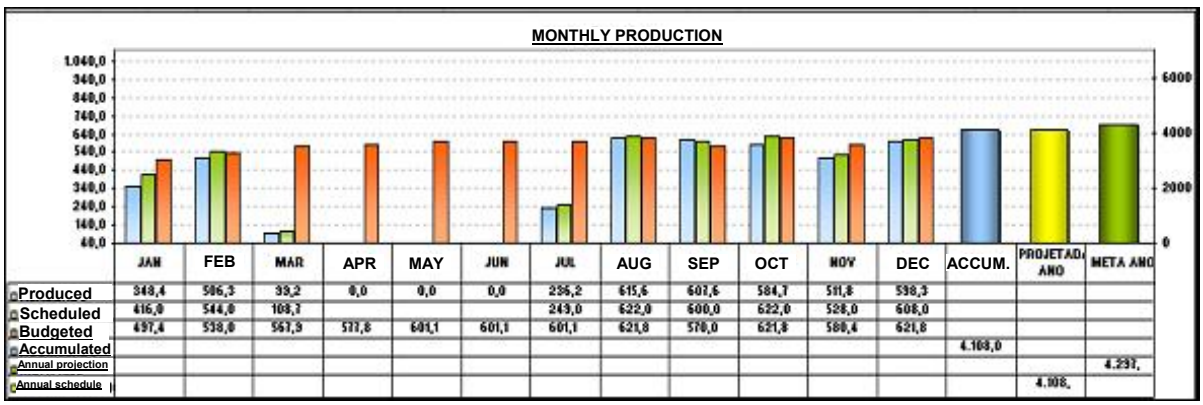
Table 7 shows that the total investment needed for the project would be US$ 18, 260, 000.00, with US$ 360, 000, 000 in 2004 and US$ 17, 900, 000.00 in 2005. This project would generate an investment per additional ton of US$ 20.3/t. This way, the investment is feasible if compared with a Greenfield Project (US$ 50/t).

Table 7. Results of the economic feasibility analysis, 2004

Results Full Equity	
VLP@12, 0% (US$MM)	**53.94**
VPI@12, 0% (US$MM)	**(18.36)**
VPL/VPI	**2.94**
TIR	**67.8%**

3 RESULTS

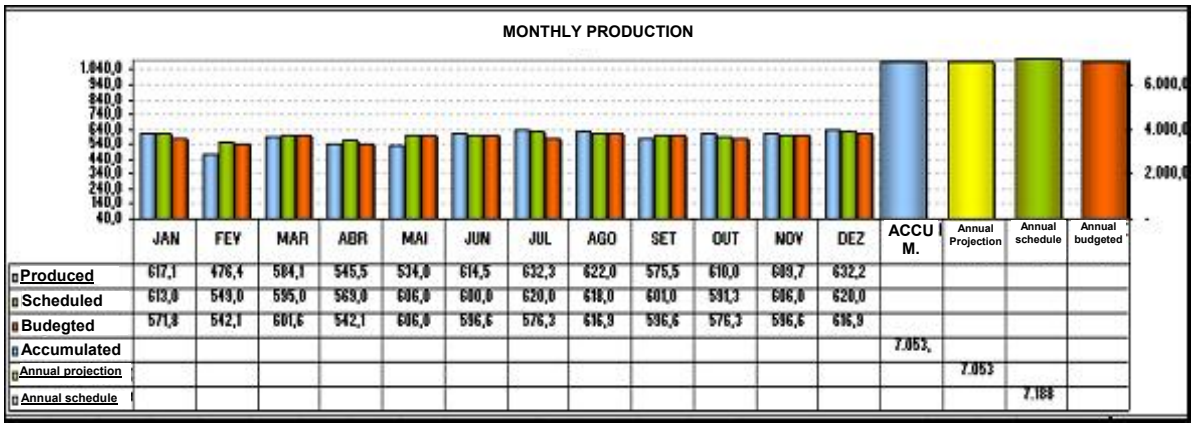
The implementation of the anticipated investments was finalized during a scheduled stoppage in January 2006. However, a strategic plant stoppage took place from 3/6 to 7/17/06, which compromised the execution of the initial production program and, consequently, prevented to verify the improvements made to increase production.



Source: U1N production program

Figure 4. U1N production chart in 2006

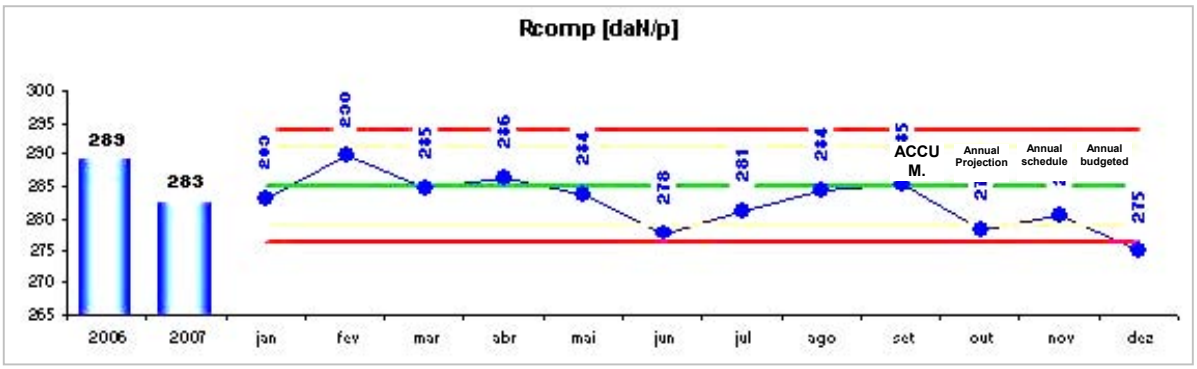
In 2007, with a favorable scenario, the plant's production is shown in with the graph below:



Source: U1N production program

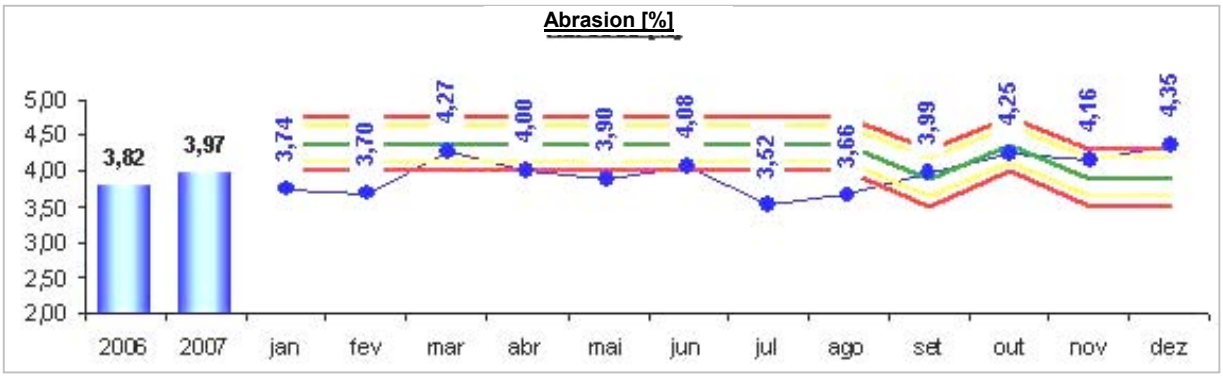
Figure 5. U1N production chart in 2006

The quality results are presented below as investment results:



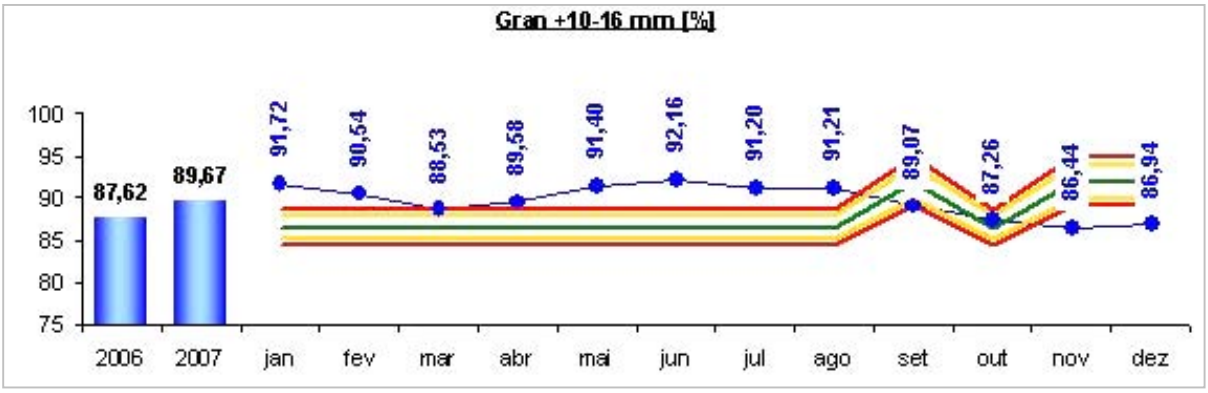
Source: U1N quality report

Figure 6. U1N physical quality parameter chart (Resistance to Compression=Rcomp)



Source: U1N quality report

Figure 7. U1N physical quality parameter chart (Abrasion).



Source: U1N quality report

Figure 8 U1N physical quality parameter chart (Granulometry = %+10-16 mm)

4 DISCUSSION

By analyzing the production and quality charts, it can be seen that the opportunities for improvements and production gains were put to good use while respecting the quality specification limits. In November and December 2007, the quality limits were flexibilized following a judicious analysis of the process and compliance with the shipments and clients' specifications. As a result, a significant production gain was reached, associated with the meeting to the clients' demands and without losses of quality limits specified by the clients.

5 CONCLUSION

We concluded that the implemented projects were properly prepared and resulted in the production of approximately 7.05 Mt/year in 2007 with guaranteed quality to clients. There are now efforts underway for a new capacity expansion to reach a target of 7.5 Mt/year; however, careful assessments of the process fans capacity and adjustments in the current parameters have yet to be made, as well as in the pertinent environmental protection parameters.

Acknowledgements
To the entire team at the North Pelletizing Plant which works hard every day in search of operational excellence. Special thanks to Liliane Durans for her dedication and effort during the preparation of this study.

REFERENCES

1 Diretória de Pelotização/VALE. Projeto de Ampliação da U1N. 2004
2 Gerência de Qualidade U1N. Relatório Diário de Qualidade. 2008
3 Gerência de Qualidade U1N. Relatório Diário de Qualidade. 2008