FURNACE MANAGEMENT IN ERAMET MANGANESE DURING THE 2009 CRISIS

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ABSTRACT

Due to the Financial Crisis the steel industry has experienced a significant reduction in demand of steel products. Corresponding capacity adjustments were made by the Manganese alloy industry. In response to the downturn in the Manganese alloy market ERAMET Manganese has reduced the production of Ferromanganese and Silicomanganese during this challenging period.

This paper will illustrate ERAMET Manganese team efforts to allow the production of alloys at reduced load, which was absolutely not the usual situation in the past years.
Four different sites, COMILOG Dunkerque (one 35 MW SiMn furnace), ERAMET Norway (three 35 to 42 MW HCFeMn furnaces and one 30 MW SiMn furnace), ERAMET Marietta (12 and 20 MW HCFeMn furnaces and one SiMn 30 MW furnace) and TINFOS Jenverk (three 30 MW SiMn furnaces) will explain their specific situation as well as their common thinking on the main issues due to this new situation, about safety, process and equipments matters. They will also explain the main issues they faced when recovering the full load on furnaces.
Finally some conclusions will be drawn on the best way to manage such difficult situations in term of safety, team management and operation costs.

1 INTRODUCTION

After a long period with a steady growth of the steel market over the world, a strong and quick drop of the steel demand occurred in Autumn 2008, leading to a sharp reduction of ferro-alloys demand over the world. The ferro-alloys inventories increased rapidly at customers and producers plants. For ERAMET COMILOG Manganese (ECM), producing Mn ores and alloys, this changed drastically the way of managing production and plants on the short term. After a very favorable period of several years during which the objective had been to increase the production capacity to follow the world trend, ECM had to adjust quickly the production levels for each site and for each product taking into account the commercial, technical and human factors. In this paper we will present how ECM dealt with the financial issue while preparing for the future market situation.

2 ERAMET Mn ALLOYS FACILITIES AND TOOLS

ERAMET COMILOG Manganese (ECM) is operating Mn alloys facilities in the main continents where steelmaking market is active:

- In Europe:
    - At COMILOG Dunkerque (CDK - France) where one 35 MW semi-open furnace can produce 70 kt of Std SiMn annually with a staff of 60 people. Electricity contract there allows either to produce full capacity or to optimize furnace operation according to market conditions.

- At ERAMET Porsgrunn (ENP - Norway) where one 30 and one 35 MW closed furnaces can produce 160 kt of Mn alloys (Std SiMn and Refined FeMn) annually with a staff of 160 people.
- At ERAMET Sauda (ENS - Norway) where one 40 and one 42 MW closed furnaces can produce 250 kt of FeMn alloys (Std SiMn and refined FeMn) annually with a staff of 180 people.
- At TINFOS Jenverk Kvinesdal (TJ - Norway) where three 30 MW closed furnaces can produce 160 kt of SiMn alloys (Std SiMn and refined FeMn) annually with a staff of 170 people.

- In the USA:
    - At ERAMET Marietta (EMI - Ohio) where three 12, 20 and 30 MW semi-open furnaces can produce 170 kt of Mn alloys (Std SiMn, Std and refined FeMn) annually with a staff of 370 people (including a part dedicated to the Chromium plant).

- In China:
    - At Guilin COMILOG (Guangxi province, South of China) where three blast-furnaces and one open 9 MW furnace can produce 150 kt mainly of HC FeMn and some Std SiMn with a staff of 990 people.
    - At Guangxi COMILOG (Guangxi province) where two blast furnaces can produce 100 kt of HC FeMn with a staff of 650 people.

In total, ECM has 1,070 kt of alloys production capacity (including China's BFs). The distribution of capacity is presented in Table 1.

Table 1: Overview of production capacity of ECM

ERAMET COMILOG MANGANESE	Country	Furnaces number	Furnaces load MW	Refining plant	Products
Comilog Dunkerque	France	1	35	-	Std SiMn
Eramet Norway Porsgrunn	Norway	2	35, 30	1	HCFeMn, Ref FeMn, Std SiMn
Eramet Norway Sauda	Norway	2	40, 42	1	HCFeMn, Ref FeMn
Tinfos Jenverk Kvinesdal	Norway	3	30, 30, 30	1	LCSiMn, Std SiMn
Eramet Marietta	USA	3	12, 20, 30	1	HCFeMn, Ref FeMn, Std SiMn
Guilin Comilog	China	5	BF 4 x 180 m3 (1), 9	-	HCFeMn, Std SiMn
Guangxi Comilog	China	2	BF 2 x 220 m3 (1)	-	HCFeMn
Total		18	370 (2)		

(1) BF shaft volume
(2) The capacity of one 200 m3 BF is equivalent to 15MW EAF one

2.1 Electricity supply

All ECM sites have flexible contracts allowing them to modulate their activity according to the market without any constraint regarding electricity supply and cost.

2.2 Manpower contracts

Temporary lay-off regulations differ from one country to another: Norway & France can benefit from governmental support, whereas China allows such temporary measures but without financial support and US's labor contract doesn't take this option into consideration.

2.3 Industrial tools and process flexibility

The process flexibility is very dependant on the type of furnace:

- BF (blast furnace) is very sensitive to the blast flow rate and pressure fluctuation, then it is not recommended to decrease load by more than 10% when running. In our case, in China, the small size of the BF (150/250m^3 as shaft volume) allows us to adjust easily the production to needs, by stopping temporarily one BF (or more).
- EAF (electric furnace) load is more flexible and can be reduced or shut down according to the market trend, but the way to do this is complex for different reasons that we will present in details in this paper.

- Refining tools are more flexible but require a stable feed from smelting furnaces; it can thus suffer from low load operation of the furnaces.

2.4 Manganese mine activity at COMILOG SA (located at Moanda in Gabon)

Since ERAMET took over COMILOG 13 years ago, the alloys plants have become integrated sites accounting for around 35% of the total output of the Mn mine with an annual consumption of nearly 1.2 Mt (2008).

The current mine capacity is 3.5 Mt per year and it is planned to increase the capacity to 4.5 Mt per year to meet the future increase in Mn demand. Mining activities are less flexible than smelting ones, therefore respond to big market drops such as that of 2008 crisis is a real challenge.

3 STEEL AND MN ALLOYS MARKET EVOLUTION

3.1 Steel market

During the last quarter of 2008, steel consumption has decreased in all the regions of the world. More crude steel customers have been destocking rather than purchasing. As a consequence, steelmakers have massively cut their outputs all around the world (especially in Europe and US).
This situation lasted until Q2 2009 before seeing fragile signs of recovery in China and about one quarter later in the rest of the world (Table 2 and Figure 3).

Table 2: Steel production

Steel output Mt	2008	2008	2008	2008	2009	2009	2009
	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Asia and Oceania	199	210	198	176	176	192	202
Rest Of the World	149	152	145	103	91	96	108
WORLD OUTPUT	348	363	342	279	268	288	310

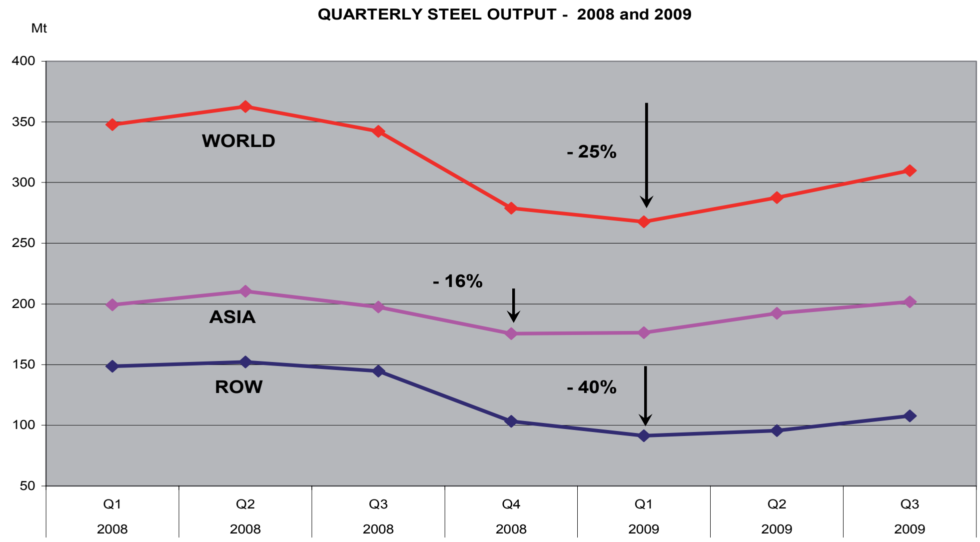

Figure 1: Evolution of steel output

3.2 Manganese market

Demand of Mn alloys by steelmakers has dropped in line with steel productions cuts.
As this weak demand was expected to continue in early 2009, Mn alloys producers have also decided strong cuts (stronger than necessary in fact) all around the world except in Asia where the steel market remained sustainable.

Main adjustments of production all around the world:
- BHP: 23% reduction planned up to mid-2009.
- Vale: stopped operations in Brazil, at RDME and reduced Mo i Rana production.
- Assmang: 20% reduction planned up to mid-2009.
- China: most alloys producers have cut Q4 2008 production by at least 20%.
- CIS: Privat and Russian producers reduced Q4 2008 production by 75% (Privat closed Nikopol and their other plants).
- Europe: many cutbacks in different places.

Eventually, Mn alloys market also showed some recovery from Q2 2009, closely linked with the steel market trend.

Table 3: Manganese alloys production

Mn alloys output Kt	2008	2008	2008	2008	2009	2009	2009
	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Asia and Oceania	2381	2617	2476	1860	1869	1991	2113
Rest Of the World	1305	1325	1257	748	523	575	899
WORLD OUTPUT	3686	3942	3733	2608	2392	2566	3012

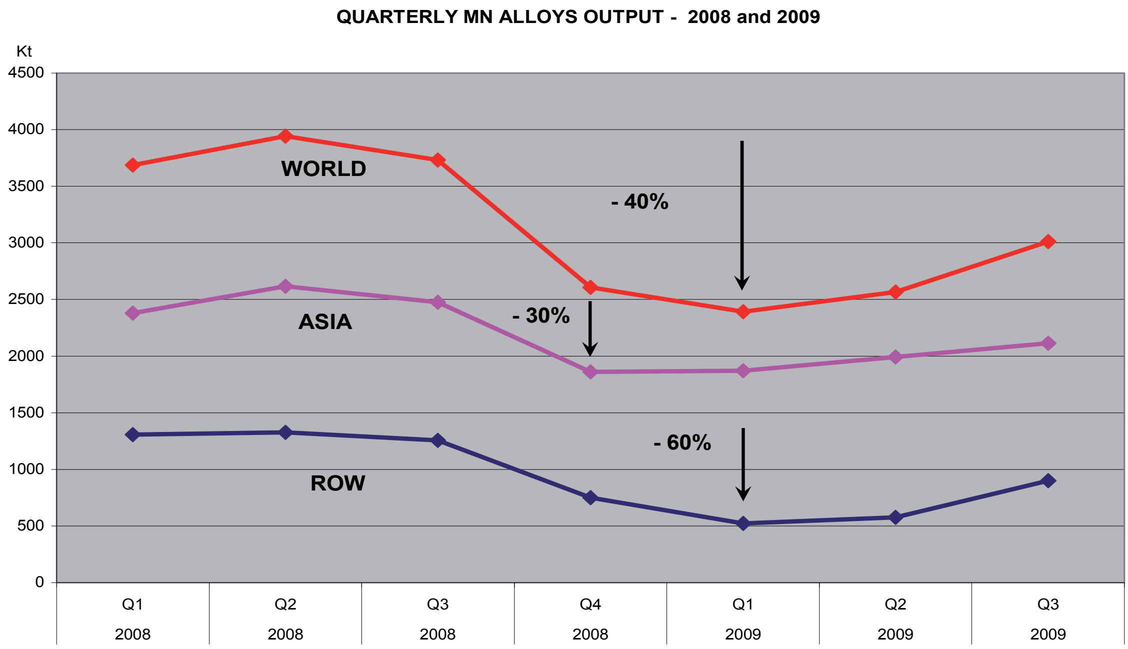

Figure 2: Evolution of manganese alloys output

4 MANAGEMENT OF THE NEW SITUATION IN ERAMET

As Mn ore and alloys producers, ECM (mine and Mn alloys sites) has started to face a difficult situation during Q4 2008: cut of sales, immediate increase of ore and alloys inventory at plants and in warehouses.

Then, early December, several decisions were taken by Company Management to face these challenges:
- Take care of the potential safety risks during the big change in the way of working.

- Organize worldwide taskforce meetings on weekly basis, involving sites and head office to follow up sales, production and inventories of ore and alloys.
- Have a close follow-up of the furnaces and other tools status through international competence groups including sites, R&D teams and Industrial Management in order to advice properly and on time the Mn Division Management on any issue related to the tools or processes.
- Manage closely and properly the HR issue to get a good fit between the available resources and the industrial needs.
- Encourage as much as possible new tests and trials on furnaces to improve our knowledge and to be able to have improved process and operation when market picks up again.

5 IMPLEMENTATION PHASE: HOW DID WE WORK TO FACE THESE CHALLENGES?

- Share industrial experiences to face the technical constraints:
    - Minimum load for each furnace.
    - Stoppage and restarting procedures.
    - Furnace burden optimization.

- Try to reach "fair" and optimized solutions within a plant and between plants through competence groups to take into account the commercial, industrial and social constraints.

- DIFFERENT SOLUTIONS depending on site, various constraints, market needs, BUT THE SAME GOAL: reduce our costs while reaching the inventories targets.

- Which solutions?
    - Based on long term vision for each plant, status of tools (see chapter on tools flexibility), social and economical environment, specific actions plans were implemented:
        - Production tools were shutdown or idled to different extent:
        - Plant or furnaces permanent shutdown (BF in Guilin)
        - Extended (> 1 year) furnace shutdown before and after revamping (ERAMET Sauda and Marietta).
        - Temporary shutdown (BF at Guilin and Guangxi, EAF at ERAMET Norway and Tinfos Jenverk).
        - Reduce load or off-peak operation (EAF at ERAMET Norway, ERAMET Marietta and COMILOG Dunkerque).
    - Power contract optimization:
        - Off -peak operation (COMILOG Dunkerque).
        - Power resale (ERAMET Norway, TINFOS Jenverk, COMILOG Dunkerque and ERAMET Marietta).
    - Social measure adapted to local environment
        - Overtime and temporary contracts cancellation (everywhere).
        - Temporary lay-off (ERAMET Norway and China).
        - Permanent lay-off (ERAMET China and Marietta).

In the eye of the storm, production level was reduced to around one third of the normal capacity.

6 MAIN TECHNICAL RISKS WHEN LOAD IS REDUCED ON Mn ALLOYS EAF

The common issues for HC FeMn and SiMn are:

- Coke balance: Mn alloys process is particularly sensitive to furnace load changes. This is mainly due to the fact that load change may improve or degrade ore pre-reduction, then decrease or increase the coke needs for Mn smelting. The consequences are detrimental: shortened electrodes, drop in reduction and higher losses in the walls.
- Lining: most of the furnaces in ECM are equipped with a freeze lining which is very sensitive to the furnace activity. Load reduction leads to slag wall build-up that reduces the furnace active zone.
- Heat losses: lower load leads to higher heat losses per ton of alloy.

- Tapping conditions: lower load also leads to lining closing in and tap-hole length to increase, then the furnace tapping is more difficult.
- Ladles skulling: more difficult tapping increases the “skulling” effect in metal ladle, which increases refractory costs.
- Electrodes baking: lower load induces lower current in electrode and thus more difficult Soderberg paste baking, especially in big size electrodes.

Some specific issues can also occur:

- In HC FeMn, there are two risks:
  - Furnace burden bridging: it is very important to follow up the feeding rate of raw materials from the furnaces bins to ensure that we have an even flow of materials all around the furnace.
  - Zinc accumulation: there is a real risk of Zn component build-up in the furnace leading to bridging and possible eruptions.
- SiMn process requires more energy and higher temperature, then Si reduction has to be closely controlled to avoid any slag production increase and accumulation, leading to electrical unbalance and difficult tapping.

7 MAIN TECHNICAL ISSUES WHEN SHUTDOWN EAF FOR WEEKS

EAF temporary shutdown (without burning down furnace) is another story and requires very careful preparation especially after a period of low load operation:

- Increase the load before the shutdown to remelt main part of the freeze lining (applied on P11).
- Prepare the ore burden by adding before and during the outage some conductive materials (coke, iron scraps) to make easier the furnace start-up.
- Apply carefully some specific procedures to avoid electrodes breakages during the start-up. This is made easier on some big furnaces of ECM thanks to paste baking continuous control by thermocouples.
- Have a safe and regular start-up curve leading step by step to recover an active reduction zone, a regular raw materials feeding and especially a regular tapping. The first tap during start-up is a sensitive point and must be safely managed, especially the MWhs amount to avoid brutal tapping.

8 RESULTS AND ISSUES/ACTIONS FOR SOME FURNACES

8.1 Porsgrunn Furnace 10: producing standard SiMn

2009 activity: load reduced and one month stoppage (Figure 3).
Main issues: few except for a brutal tapping after shutdown (no safety consequence but some wear on tapping equipment)

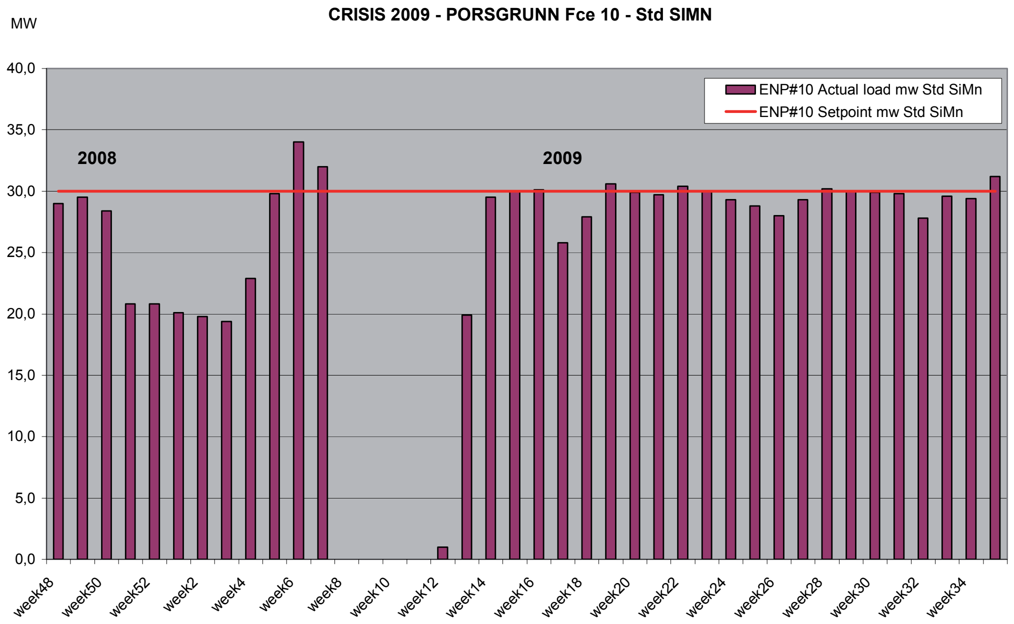

Figure 3: Load ENP 10

8.2 Porsgrunn Furnace 11: producing HCFeMn

2009 activity: load reduced and two stoppages, one and two months (Figure 4).

Main issues: no major event except for some tapping difficulties during the reduced load period. Adjustment of refractory cooling at tap-hole was enough to solve the problem.

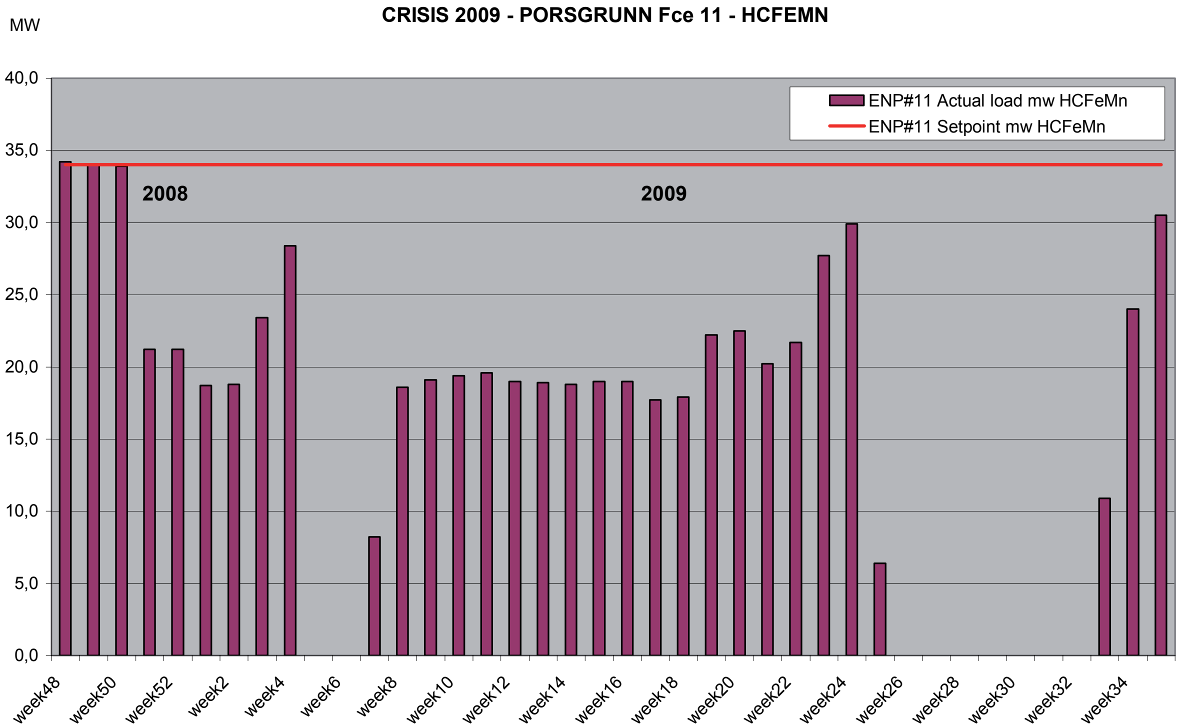

Figure 4: Load ENP 11

8.3 Sauda Furnace 11: producing HC FeMn

Upgraded furnace (load 26 to 42 MW) was commissioned in summer 2008 and should have started-up in October 2008. Due to the crisis, start-up has been postponed by one year and finally was done in September 2009.
The main issue was to keep the furnace lining in good shape, especially by heating it carefully during winter, to avoid any further trouble during operation.

8.4 Sauda Furnace 12: producing HC FeMn

2009 activity: load reduced for a long period (Figure 5).
Main issues: few issues except for tapping difficulties solved by the same way as Porsgrunn Fce 11. Electrode baking was well managed by limiting the load decrease to 50% of the set-point.

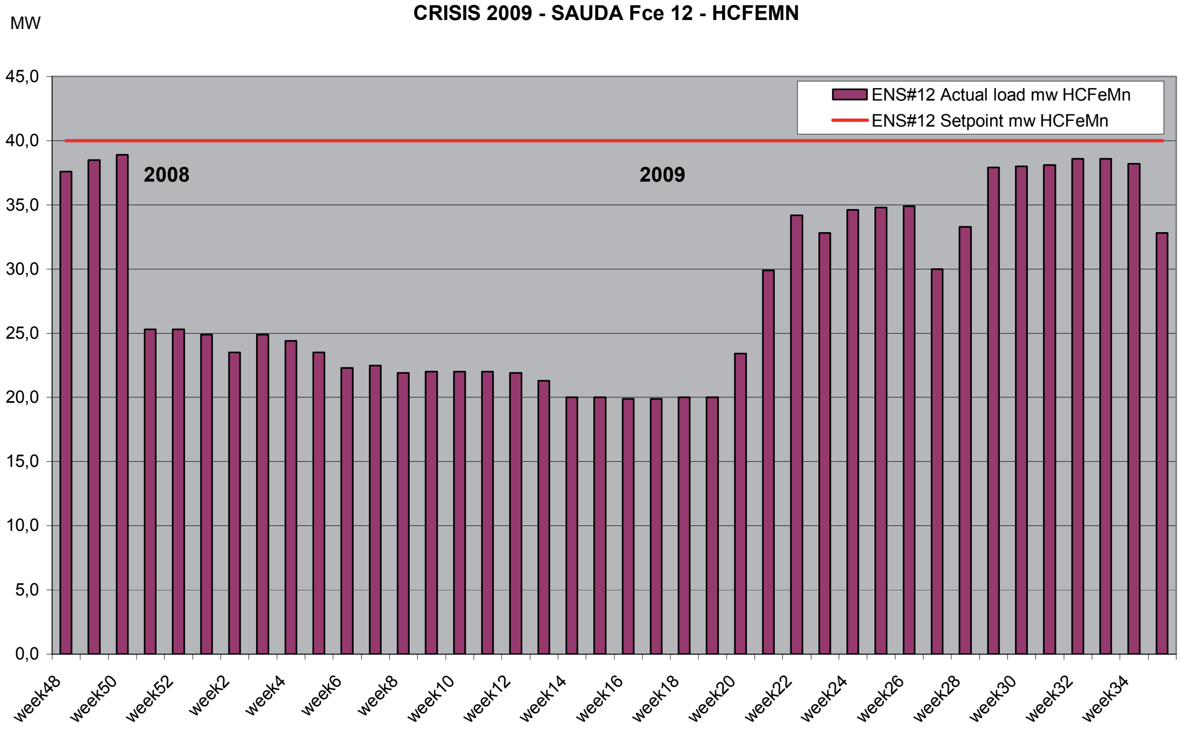

Figure 5: Load ENS 12

8.5 Marietta furnace 1: producing standard SiMn

2009 activity: load reduced for a very long period (Figure 6).
Main issues: no issue. This furnace was relined in 2007 and is equipped with the last monitoring technology for lining follow-up.

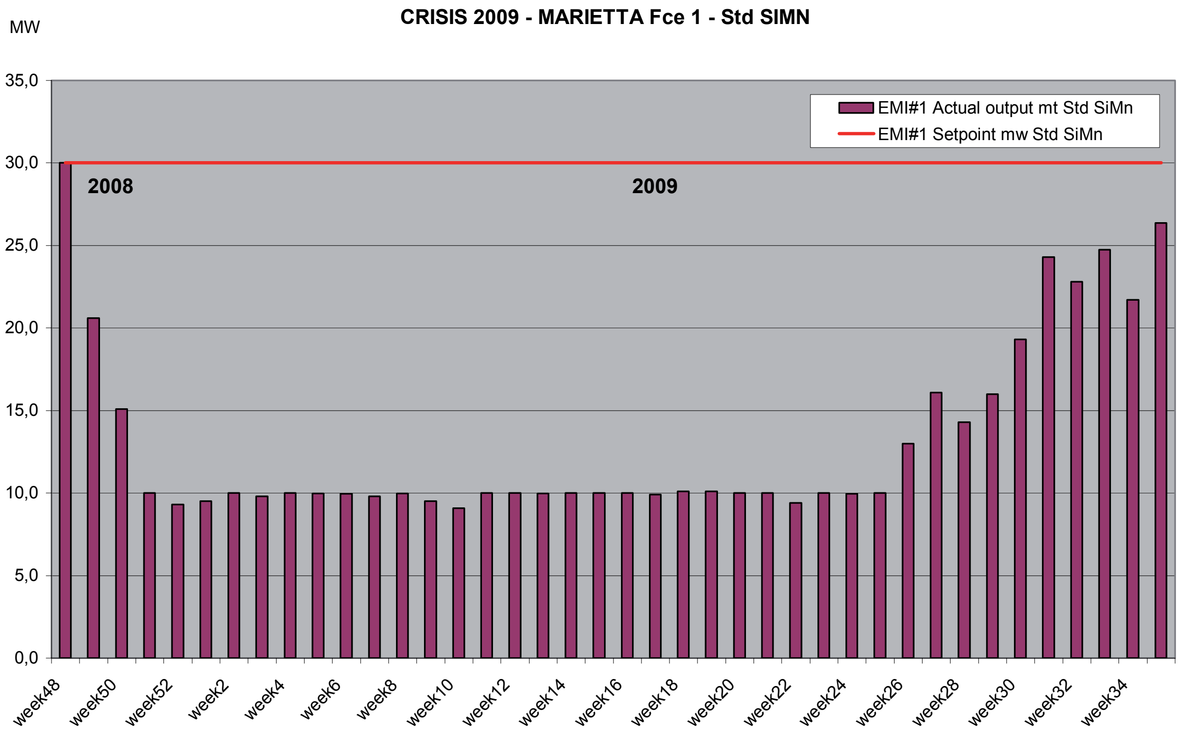

Figure 6: Load EMI 1

8.6 Dunkerque: producing standard SiMn

2009 activity: load reduced during the daily period and furnace shutdown a few hours per day - 5 days on 7 (Figure 7).
Main issues: at the beginning, Si reduction was difficult and the problem was solved quickly by adjusting first the load setting and then the coke amount fed to the furnace.

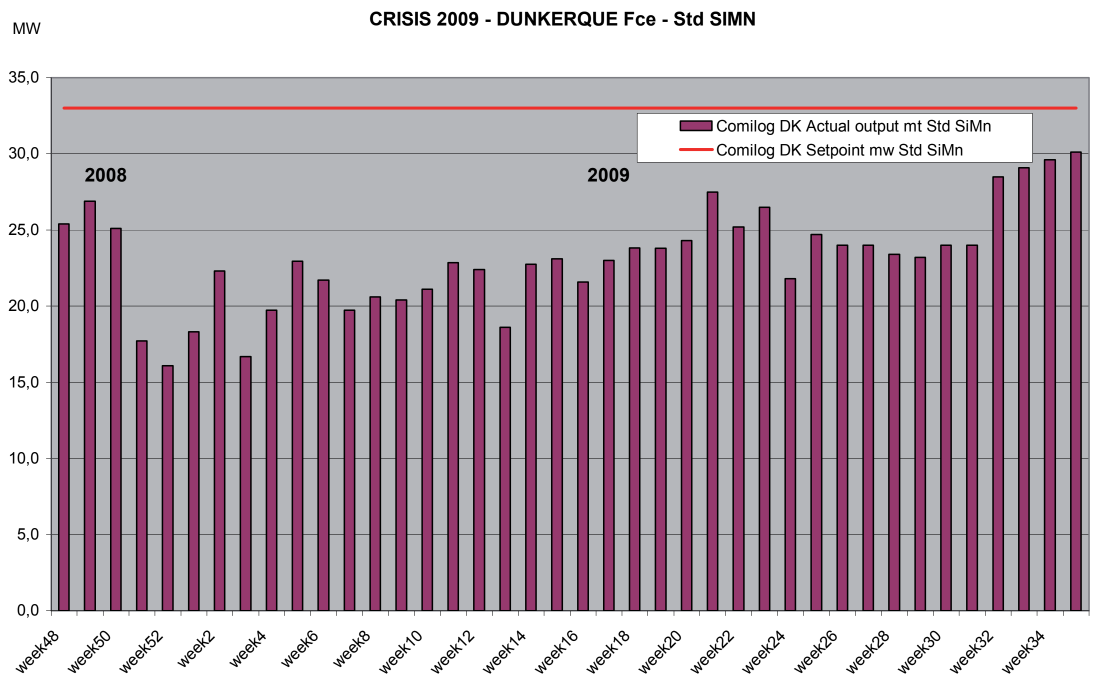

Figure 7: Load DK

9 CONCLUSIONS

The purpose of this paper was to describe the industrial policy for furnaces management in ERAMET COMILOG Manganese during the 2009 crisis.

The way ECM has managed this situation is probably not spectacular, but thanks to a very intense teamwork between sites (with different philosophy and practices of this kind of situation), Industrial Management and R&D teams, to identify and tackle the main technical issues. It worked well and lead to smooth but flexible operation.

ECM team also worked hard to perform some difficult tests on ore preparation, new raw materials and on furnace process management that will help us a lot in the coming years to keep a stable operation and improve performances.

Finally this step was also a perfect way to enhance TINFOS Jenverk integration through the International Competence Groups.