# A NEW ERA FOR THE CONTINUOUS SCRAP CHARGE: THE DEFINITIVE SUCCESS OF CONSTEEL® TECHNOLOGY AND ITS EXPANSION IN EUROPE FROM A PRODUCTIVITY AND ENVIRONMENTAL PERSPECTIVE[1]

*Francesco Memoli*[2]
*Jorge Villares de Freitas*[3]

**Abstract**

Many Consteel® System installations have been commissioned in the past years. This paper presents the evolution of the Consteel® technology and includes all the new features that were developed on its way to success as the only real alternative to the conventional Electric Arc Furnace. From the first applications in the United States when scrap preheating was important to reduce variable costs, the Consteel® System strongly expanded in China providing high productivity increases, and later in Europe, where another key for its success has being consolidated: considerations for the environmental aspects of the technology.
**Key words**: Continuous scrap charge; Scrap preheat; Cost reduction; Productivity increase.

## UMA NOVA ERA PARA O CARREGAMENTO CONTÍNUO DE SUCATA: O SUCESSO DEFINITIVO DA TECNOLOGIA CONSTEEL® E SUA EXPANSÃO NA EUROPA POR UMA PERSPECTIVA DE PRODUTIVIDADE E AMBIENTAL

**Resumo**

Várias instalações do Sistema Consteel® foram comissionadas nos últimos anos. Este trabalho apresenta a evolução da tecnologia Consteel® e inclui todas as novas características que foram desenvolvidas na sua trajetória de sucesso como a única alternativa real para o Forno Elétrico a Arco convencional. Das primeiras aplicações nos Estados Unidos quando o pré-aquecimento de sucata era importante para reduzir custos variáveis, o Sistema Consteel® se expandiu fortemente na China propiciando grandes aumentos de produtividade, e mais tarde na Europa, onde outro fator chave para o seu sucesso tem se consolidado: considerações sobre os aspectos ambientais da tecnologia.
**Palavras-chave**: Carregamento contínuo de sucata; Pré-aquecimento de sucata; Redução de custos; Aumento de produtividade.

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[1] *Tecnhical contribution to XXXVIII Steelmaking Seminar – International, May 20th to 23rd, 2007, Belo Horizonte, MG, Brazil.*
[2] *Area Manager North and South America, Tenova (Techint Group), Metal Making, Milan, Italy*
[3] *Director, FHE Freitas & Heer Engenharia, São Paulo, SP, Brazil*

## 1 THE BEGINNINGS: JOHN VALLOMY AND THE INSTALLATIONS IN AMERICA

A brief report of the career of John A. Vallomy is a must when start writing about Consteel® history. He is one of those engineers in the steel industry who has the capacity to look at things not in a conventional way and he has to be considered not only the inventor of the Consteel®, but the real innovator in the way of producing liquid steel with an Electric Arc Furnace. Mr. Vallomy is from Valle d'Aosta, the north-west Alps region of Italy, at the border with France. His career in the steel industry started in 1956 at Fonderie e Acciaierie Liguri, Italy. After only two years, he decided to move to Veracruz (Mexico) where he stayed from '57 to '64 at Tubos de Aceros de Mexico – now TenarisTamsa – as assistant to the Steel Division Manager. In 1964 he decided to move to Argentina, certainly a Country with a better climate, more similar to the one he was used in Italy. There he became Manager of the Steel Division in Siderca Steel Plant – now Tenaris-Siderca – where he worked until 1979 and it is there where he developed the first ideas on the scrap continuous charging.
The use in Siderca of DRI pellets, charged into the EAF by belt, as the main metallic charge has been one of the drives for the Consteel® invention. For what concerns DRI, at that time, it was *in vogue* the German theory of the "iceberg": quick addition of the pellets, to create icebergs of metallic charge then to be melted. Vallomy's practice was different indeed: avoid icebergs and constantly melt the pellets that were added smoothly. «I have not discovered anything really new», he use to say today when he is asked about the Consteel® beginnings, «we were continuously charging the EAF with pellets since years: doing that with scrap was a natural consequence. If this is working for DRI, why it should not work for scrap? The point was to find the way to do it in a safe and reliable way, adding the crucial function of scrap preheating». As always, great ideas come from simple things: «The Consteel® technology», Vallomy says, «comes from the combination of existing practices, as the continuous charge; of existing equipment, as the slip-stick conveyors, and steel plant requirements, as cost reduction though scrap preheating».(1)
After 1979 he decided to devote himself to equipment engineering and to commit to innovation. «Real innovation is difficult to be done in a big Group», is what he says, «you can much easily innovate in a small Company». And this is why, after few years as consultant, he created his own Company, Intersteel Technology Inc., based in Charlotte, NC. Nucor has been the first Steel Company in the World to believe in the Consteel® and to test the scrap continuous charging and preheating of Vallomy. It's been in Darlington (SC) in the second half of the '80 where the Vallomy's project, designed by a British draftsman who were working with him in those years, became reality. A 30 tons AC EAF was chosen by Nucor to test the first Consteel® of the history, remembered as the "L" Consteel® because of the 90° angle of the charging conveyors. The first furnace retrofitted with Consteel process at Nucor Darlington was already featuring «computer control operation and continuous charging of scrap from railroad cars to the melting system.(2) It's been there where a lot of issues came out, a lot of things that some time later will be discovered as real secret of the success of this technology: foamy slag on top of the others.(3)
Anyway, important features were already clear at that time: the environment inside and outside of the steel plant was «improved by decreasing levels of noise and hazardous emissions»,(4) and the continuous melting process was clearly more effective than the batch process, because could be thoroughly controlled at any point in time. Moreover, preheating up with primary fuel was more economic than introducing the same heat with electric energy in the furnace.(5)

At that time, incidentally, Nucor was also pushing for the DC technology, and the project of a DC furnace for Darlington was for them a priority; the Consteel® prototype plant then had been mothballed in Dec 1988, also due to the problems arose with the retrofitted operation.
In November 1989 the first Consteel® system came on stream at Florida Steel Corporation's Charlotte, North Carolina, USA, minimill – today Gerdau Ameristeel Charlotte – as part of the $13 million Charlotte mill expansion, to increase the facility's 200 000 ton/year steelmaking capacity by an average of 30%.[6] The melting operation was utilizing a 5 m diameter furnace – 22 MW power input and a 42 ton heat size – , a conveying system capable of delivering 1.5 tons of scrap/min at temperatures higher than 260 $^{o}$C, a 38 m long preheating conveyor and a 40 m long charging conveyor. The system was placed in a new melt shop built parallel to the existing one. The tapping axis of the new furnace was built to coincide with the axis of one of the existing furnaces, which then was revamped into a ladle metallurgy station.[7] It's been there where the fist Consteel® really born. The practice of foamy slag was already on its way to optimization: «Slag formers and slag foaming additions are added, and oxygen is injected to continuously refine the melted steel, to minimize the refractory erosion, to shield the arc, thus optimizing the transfer to the metal bath of the heat generated in the arc, to keep the bath homogeneous in composition and temperature, and to produce carbon monoxide, which is fuel for the preheater».[8]
«The Consteel® installation at Florida Steel's Charlotte, NC, plant has proved to be economically viable. It has produced a savings in power and electrode consumption, labor costs and dust disposal. In addition, production levels are climbing and continue to improve», as reported by H. Herin and T. Busbee in the Electric Furnace Conference in 1995.[9] Safety issues of this new system, besides the productivity and cost benefits, were one of the first things to be observed by the workers: No handling of scrap and buckets out of the scrap yard increased the security for people. Scrap was only charged, as it is today, onto the conveyor.
Concept of slip-stick conveyor at that time was not well known to the steel industry. Its application was mainly for small foundries and some other industries, including food. The challenge was to use slip-stick for big and heavy scrap, so that the existing types of conveyors had to be re-engineered to fit the new requirements, but the goal had been achieved (nowadays slip-stick conveyors are operating in Consteel® applications up to 300 ton furnaces, charging scrap up to 3 meters long).
«Thermal incineration of flue gases reduced emissions to levels set by any environmental regulations in the world», as reported by Vallomy, Fuse, and Nakamura at the Electric Furnace Conference in Atlanta, in 1992. «The flue gas-dust in the Consteel process is about 60% that in conventional processes».[10] This matter was indeed a main driver for the decision to install the second Consteel® equipment, started up early in October 1992 for the 110 metric ton furnace of the Japanese plant Kyoei Steel at Nagoya Works.
Few months later, Nucor Darlington eventually decided to order the Consteel®, which started to operate in September 1993. The Nucor Darlington project was somewhat a challenge: stop existing AC furnaces and run with one Consteel® 100 ton DC furnace. The reliability of the system and the benefits in term of productivity and cost reduction contributed to reach the target.
Every new and good idea has its own detractors, and Consteel® has not been an exception. Those, the '90, were the years of the competition between the scrap continuous charging/preheating against the vertical shaft preheating system. Preheating steel scrap prior to charging offered the potential for reducing the overall energy consumption of the electric arc furnace, but scrap preheating was still considered a developing technology.[11]

However a growing number of companies were already reducing power consumption by using the exhaust gases of arc furnaces to preheat scrap, and between then the three Consteel® in the US were performing particularly well.[12]
At that time the shaft technology certainly was very attractive, being a vertical preheater that could use a lot of the sensible and latent heat of the EAF fumes. Nonetheless, in a study issued by the Climate Protection Division – Office of Air and Radiation – of the U.S. EPA – the Environmental Protection Agency – considering the cumulative primary energy savings of the shaft and the Consteel®, for the first one the savings were only 0,24 GJ/tonne, while for the Consteel® the savings were calculated up to 0,74 GJ/tonne, being that three times more. In the same study, the IRR of a Consteel® plant was calculated around 76% with an average payback time of 1.3 years.[13] These facts were giving to the technology a lot of attractiveness: talking only about electrical energy reduction, electricity consumption in EAFs was estimated at an average of 436 kWh/ton, which can be decreased to approximately 335-355 kWh/ton using the Consteel® process.[14] Moreover, in a study of the Centre for Material Production and the Steel Manufacturer's Association about the methods to reduce the volume of dust generated during steelmaking, the Consteel process, as one of the best preheating technologies, was proven to reduce dust discharged from the furnace by eliminating back charge.[15] In addition to that, an important factor had already been proved: the reduction of flickers. «Electric arc furnace operators need to limit electrical disturbance to the network. In many cases additional investments in the electrical equipment are necessary to reduce the flicker voltage fluctuations. By feeding scrap continuously, the Consteel process is a technology to considerably reduce electrical disturbances to the network with minimum capital cost», was reported some years later by Mr. Vallomy in the MPT review.[16]
There also was a lot of people resistant to change and to innovation, including the same people operating the fist Consteel® systems. One of the issues underlined by critics was that the scrap, entering from one side of the furnace, would have irremediably frozen that side. That is certainly not true: «if you have a pot on fire with boiling water» Vallomy use to say «you can smoothly add ice and the water will keep boiling, if you control the addition», that's so simple, like the Consteel®.
In May 1994 the fourth installation started up at New Jersey Steel – today Gerdau Ameristeel Sayreville, NJ. One of the new features of that project was the introduction of the Dynamic Seal – the system that avoids fresh air entering the dedusting system from scrap tunnel entrance – for the first time.[17] It is also remarkable that today, thirteen years after the start-up, the original gantry crane installed at Sayreville, coming as second-hand equipment from Canada, where it was used for tree trunks, is still in function.
A major question was however in the minds of everyone, including the steelmaker, whether Consteel® was really «friendly to the environment. It has been demonstrated by the process that it is meeting local and national regulations on the control of pollution of all kinds: air, soil, water, and noise».[18]
Besides the success of the American and the Japanese installations, Intersteel Technology Inc. found out that a bigger partner was necessary in order to sell more systems, to develop the market. The opportunity came with the contract of NSM, Nakornthai Strip Mills (Thailand), a completely new Minimill where the Consteel® was part of the project for a new Greenfield 180 metric ton EAF, 230 t/h, the biggest in Thailand, also equipped with compact strip production (CSP) technology. As a matter of fact, this has been the first system for flat product and the first hot strip mill in all Southeast Asia. NSM started the production during the summer of 1997; the plant had been foreseen for 1,500,000 t/y of hot strip coil.[19]

At that time, the Techint Group was looking for updated technology to boost its Meltshop activities. Intersteel and Techint, above and beyond a mutual interest, immediately found a good feeling «owing to the spirit and determination of its people», as Mr. di Carpegna Varini – President of Techint Meltshop Business Unit – used to say. The entrance of Intersteel Technology into the big constellation of Techint Group took place in 1997.

## 2 THE GROWTH: CONSTEEL® SYSTEMS IN THE CHINESE MARKET

The bridge between the American period to the following Chinese growth has been the project of ORI Martin, in Italy. This plant is located in the middle of Brescia city, the heart of Italian steelmaking tradition. In the middle of the '90 the claims for environmental improvements from local authorities and people living in the neighbourhoods were becoming more and more intense. On top of that the less that 10-years old conventional EAF was performing very badly, above all in terms of maintenance.[20] The installation of some equipment that could guarantee noise reduction, less emissions and better productivity was more than a need. Mr. De Miranda, one of the owners of ORI, immediately decided to send his Meltshop Superintendent, Mr. Zanforlin, to visit the plants in the US that were operating the Consteel®. After a following visit to the Japanese plant of the same Mr. De Miranda, ORI realized that this was the right way. The erection of the Consteel® and the new EAF of Techint took place in the four weeks of the typical Italian summer shutdown, August 1998. In 30 days the Consteel® and EAF foundation were completed and the equipment was mounted, tested and started-up. This record of the quickest commissioning for a Consteel® hasn't been beaten yet.
Performances of 318 kWh per metric ton where reached in November '98 under the Techint supervision, but the day after ORI workers – following the Bresciani pride – decided to demonstrate to be better and they started to perform 312 kWh per metric ton average heats of rebar steel. ORI anyway has always produced steel grades for automotive industry, with different specific consumption depending on steel grate and scrap type. What has never changed has been the remarkable results in terms of electrode consumption,[21] which has moved from 2,6 of the conventional EAF to less than 1,1 reached consistently on a yearly base and the very interesting results in terms of Nitrogen ppm reduction; actually, melting under foamy slag, as in this kind of process, led to the 15 ppm decrease of the nitrogen content in steel.[22]
Besides the electrical energy benefits, the Consteel® availability reached 99,4% of the time: «I was sceptic» said the maintenance manager of ORI, Mr. Quintavalle, few months later, «but now I have to admit that we are in the paradise of maintenance».
«In nine years we have changed three EAF panels in total, and all three in September '99» Mr. Zanforlin says today. «Actually my maintenance crew is formed by young guys, all hired after 1999, so that they have seen a panel change procedure only on the maintenance manuals, never in reality».
ORI Martin has also been an important development site for many of the technologies that nowadays are applied on the system, as the automatic control of the scrap speed based on the on-line measurement of the EAF weight and thus the calculation of the specific energy consumption. It's been in ORI Martin where this automation feature has been successfully implemented, in order to leave to the EAF operator only a task of supervision to the process, without any real manual intervention during the melting and refining phase.[23,24] An additional technical detail which has been added in ORI has been the continuous charge of lump carbon and lime by belt onto the connecting car conveyor, the way in which this function on the new Consteel® is designed today.

In ORI Martin works, Techint and the CSM – “Centro Sviluppo Materiali”, the Italian research centre for innovation in materials and in related production, design and application technologies founded in 1963 – investigated and improved the preheating capabilities of the Consteel® technology.[25] As a matter of fact, the researches completed between 1999 and 2000 demonstrated that the EAF off-gases are flowing into the preheating tunnel at a temperature constantly above 900°C and they preheats the scrap charge up to a surface temperature above 600°C and an average temperature in the range of 300/400 °C according to the type of charged scrap.

The late nineties were also the early years of Chinese boom in steel. Chinese government were preparing the path for what is today their powerful presence in the world steel market. «[…] A remarkable achievement has been gained on steel-making technology with electric arc furnace in China, on the basis of introducing and digesting foreign advanced technology, keeping innovating continuously», as per Mr. Fu Jie of Beijing University of Science and Technology.[26] At that time they were “collecting” all new available technologies in steel production and Consteel® has been an important part of it. China was for sure interested in what Europe was doing, but much more fascinated in what was operating in the United States: the real American new technology for steelmaking was Consteel®.

The driving forces for China were three: electricity, environment and scrap quality. China has always had issues and concerns with its power networks, and that became one of the key points for the commercialization of the system for that Country: less power required, less flickers, more stable active power demand, no need of Static Var Compensators for the majority of the cases. The reduction of the electrical energy consumption was of course one important topic, but the benefits in terms of environment – as the reduction of 30% of the dust in the off-gasses – were crucial to obtain the environmental permits to operate such technology, conceived also as scrap preheating equipment. The experience of ORI Martin and the awards in terms of environment obtained by the European Union authorities played an important role in that. The scrap was then the final challenge, but Chinese steelmakers realized that they could charge on the conveyors whatever scrap quality and whatever scrap mix; the flexibility to charge from one hundred percent heavy and large scrap to hundred percent turnings, and of course bushings, shredded, wire rolls, billets and pipes and even tundish skulls, gave Chinese steelmaking the flexibility they were looking for in a country where scrap quality, availability, selection and preparation has always been a problem.

For the installation of new Meltshops in China was mandatory to deal with the so called Design Institutes, which at that time were given the task by the government to take care of the implementation of any project in this field. These were the CERIS (Central Engineering and Research Incorporation of Iron & Steel Industry), the BERIS (Baotou Engineering and Research Corp. of Iron and Steel Industry), the WISDRI (Wuhan Iron and Steel Design and Research Institute) and the CISDRI (Chongqing Iron and Steel Design and Research Institute), which now are becoming private engineering companies and main contractors.

CERIS has certainly been the first of these Design Institutes to be fascinated by the Consteel® concept and with CERIS taking care of the buildings, foundations, water treatment plant and in some cases even dedusting systems, the first three Consteel® plants have been realized. The duty of the Design Institutes was starting at the first stages of the projects, as they were responsible for the authorities of feasibility studies and the preparation of the technical documentation for government approval, including the authorities at Provincial and Municipality levels, which were also in charge of the financing issues.

«Perseverance, motivation, commitment and determination to reach the target have always been the distinctive features of our Chinese Clients», says Mr. Giuliano Fanutti, Area Manager of China and South East Asia for Techint. «They loved those challenges, typical of the modern Chinese culture, and in particular the challenge of speed: reduce to the minimum the duration of the project from the signature to the fist billet».
The two Chinese projects of Guiyang and Xining can be in fact considered the starting up of Techint experience in China for Consteel®. One of the reasons of the later success of this technology in China can be explained by the fact that the relation between Techint technicians and Chinese personnel started from the beginning in the right way: respect and dedication from both sides. In fact, in 1999 these two Chinese Companies, during the purchase of the system, they required not only the supply of equipments and engineering, but also an extensive training off-site, in Italy. Techint, in agreement with ORI Martin, assisted big groups of Chinese delegations (20-30 people each group) attending supervisor's classes on mechanics, electrical and process/metallurgy. In this way the difficulties of the start-up of this new system in a new country were smoothed.
Also in the case of the third Chinese project, Shaoguan, the Client sent a delegation for training in ORI Martin, but this project will be remembered for two important technical achievements. The first is that Shaoguan has achieved the shortest construction time for Consteel® EAF and caster in Asia; the second is that it's been in Shaoguan were the first Hot Metal continuous charging system has been applied onto a Consteel®. «Hot Metal charging brings a lot of heat to the bath» as reported by Mr. Wang Sanwu during the convention "Consteel® day", held in Shaoguan (China) on April 2004; «when about 30% Hot Metal is charged and oxygen injection maintains at a high flow rate, it will also produce more chemical heat and reduce electric power consumption more than 80 kWh».[27] A proper power supply «can be the key factor for saving energy and prevent the molten steel over heating. After Hot Metal charging into the bath, great amount of CO, carbon monoxide, will be produced in the bath, which will make the slag be ready to form foam». Nowadays Shaoguan has moved to massive utilization of the Hot Metal addition; as a matter of fact this is the only EAF plant that can utilize Hot Metal exceeding 80% in a very consistent way, having improved its oxygen injection and having developed its own metallurgical process.
The Consteel® of Wuxi Xuefeng Iron & Steel Co. Ltd., located two hours distance from Shanghai, is one of the other examples of projects where the deep cooperation between the supplier and the steelmaker has produced not only excellent operational results, but also a lot of new features, process management wise, that today are indicated as good examples to follow for the new Consteel® users. As stated by Mr. Tang's speech at the Consteel® day «Xuefeng Company acquired the Techint equipment in the year 2000. The decision was made with target production of 500,000 tonnes/year of billet, using the existing buildings and other auxiliary equipment to lower the project investment. After comparison and considering the existing condition, the Consteel® was selected. […] The furnace was started up on Sep. 6th 2001. 500,000 tonnes of billet had been produced by Sep. 2002, achieving the rated annual production within the first year after the start up».[28]
«It is difficult to judge the effectiveness of the preheating of the scrap in the preheater» said Mr. Tang. «We made a test: a detecting probe was inserted between the preheating hood. After a certain time of preheating, the probe was taken out and its temperature measured immediately. […] The result of the measurement shows that the top layer of the scrap can be preheated to even more than 600°C (1100°F). […] The average temperature of the scrap can reach 500°C before entering into the furnace». Mr. Tang's experiments on different types of scrap, and the outstanding results in terms of electrical

energy consumption, confirmed then what has been tested by Techint in ORI Martin some months before, giving consistency to Techint's statements on scrap preheating capabilities of the Consteel® system.
During the Consteel® day conference, Wuxi people realized that the Hot Metal charge to the Consteel® EAF was very beneficial and thanks to the availability of Hot Metal in that plant the project for the construction of a H.M. charging system, similar to the one of Shaoguan, started up. «By charging Hot Metal continuously, the process of Consteel EAF is optimized», as reported by Mr. Zheng Shusheng of Shiheng Special Steel, one of the seven out of nine Chinese Consteel® plants which is using Hot Metal charge in the EAF. «When charging 30% Hot Metal, the effect on technical and economical figures is remarkable; improving the ratio of Hot Metal can further more dilute harmful elements in liquid steel and improve its purity, thus can increase steel grades and decrease cost».(29)
Following the Consteel® at Shiheng, the trend continued with the installation of the Consteel® system in other four steel plants: Echeng, Tonghua, Hengli and Jaxing. During the execution of the Jaxing Consteel EAF project in the years 2004-2005 the Chinese policy for steel production changed, introducing limitation on the power supply and on the import of scrap. The new conditions became favourable for the installation of the Blast Furnace-Converter line which characterised the recent growth of the steel production in China untill reaching nearly 450,000 tonnes in the year 2006 with only 14% produced by Electric Arc Furnaces. Coming back to Wuxi, the confirmation of the excellent process management and consequent performances of that equipment is demonstrated by the fact that now that is a plant where some of new users of the Consteel® are going there for training. «we visited Wuxi plant during the evaluation of our investment to see if it was worth to give our people an appropriate training before the start up of our new Consteel®» said Mr. Volkwin Köster, Steel Plant Director of Trierer Stahlwerk GmbH, «here in Wuxi we realized that besides excellent equipment and operation, we can find excellent people to train our German workers. This plant fits perfectly all our requirements». During the days of the Chinese period also two systems have been started-up in North America: Nucor Hertford, with 150 ton-size the biggest American Consteel® to the date, and Ameristeel Knoxville – today Gerdau Ameristeel Knoxville – 67 t/h Consteel® replacing two 35-ton Lectromelt furnaces that were installed in 1972.(30)
These two projects have eventually confirmed the important benefits of the Consteel®, to the extent that they have been purchased by Steel Companies in which the same technology was already applied (Darlington for Nucor and Charlotte for Ameristeel). Some years later, during the 59th Electric Furnace Conference in Phoenix, AZ, the paper that Knoxville prepared for the occasion reported the reasons for the choice of the Consteel® technology: reduced baghouse capacity, minor changes to substation and Static Var, no use of natural gas, moderate use of cooling water, scrap preheating and low capital cost. «The successful engineering, design, construction, and startup of the new Knoxville melt shop project», as per Knoxville paper, see references, « […] continues to be a source of pride and achievement within AmeriSteel Corporation». (31)

## 3 THE SUCCESS: EUROPE, PRODUCTIVITY AND ENVIRONMENTAL PERSPECTIVE

The Consteel® installation of Wheeling Pittsburgh in Mingo Junction works, OH, has been right in between the Chinese period and the present European years. «The world's largest Consteel® furnace, installed at Wheeling-Pittsburgh Steel's Mingo Junction plant, demonstrates the flexibility of the Consteel process».(32) Wheeling is to the date the largest Consteel® unit in operation in the world and the first unit built in the U.S. designed to continuously feed Hot Metal along with scrap into a new EAF. The Consteel® EAF has a

nominal capacity of 250 ton/hour, which can be increased up to 330 ton/hour when fed with a 40% Hot Metal and 60% scrap mix. This installation has replaced one of the existing Blast Furnaces and its supporting coke batteries. This project has been a proof for all integrated steel plants that want to reduce production costs without compromising the steel grade quality of their products. They have in Wheeling a demonstration that they can benefit from the unique characteristics of Consteel® melting process, especially if they are facing limited and weak power supply and have environmental constraints. [(33)]
Trials were conducted utilizing Hot Metal charge in the EAF between June and August 2005. «The major operating cost benefit when using Hot Metal is the savings in electrical energy», as presented by Wheeling Pitt to the AISTech2006.[(34)] «A reduction of 62 kWh per liquid steel ton was realized with 69.1 tons (21.7%) of Hot Metal charged [per heat]. This agrees favourably with the theoretical energy content of Hot Metal […]».
For years big investments were not foreseen in Europe. Environmental constrains and labour costs have not been an incentive for the big and small Steel Companies. In general the local authorities have not helped the Steel Industry in these last years.
This is still the present scenario in Europe, where a lot of small steel plants have been forced to close or to reconvert their production from common rebar steel to special steel, in order to increase the added value of their final product. So, whenever some money was left to invest, the priorities were almost two: new dedusting systems to maintain the production permits and equipment to increase the qualities of the steel grades. In this way it can be explained, at least partially, the reason why Consteel® has not been one of the major equipment sold in Europe in the last decade. Now something has changed; more than 50% of the Consteel® Systems sold after the Chinese boom are located in Europe and the last one, the Consteel® that will be placed in Cremona, Italy, at Arvedi works, will be the biggest of the world: 250 metric tons Consteel® EAF foreseen for its new "endless steel production" (ESP) line at Cremona, Italy. This integrated system is targeting a world-wide highest capacity for a single furnace: 300 tonnes/hour with 100% scrap and pig iron feeding.[(35)] In the meantime Techint has decided to create an independent company named Tenova, which will take the place of what has been Techint Technologies in the supply of equipment for Steel plants, so it will be the new Company Tenova to provide Arvedi with one 110 m Consteel® composed by two 35 m charging conveyors and one 40 m preheating section; the conveyor will have a width of more than 2500 mm and a height of about 130 mm. Metallic charge will move on the conveyor at a speed of about 6 m/min in order to deliver to the EAF of 8.5 m diameter a charging rate of 430 metric tons per hour. Other impressive numbers are coming from the electrical side, as a matter of fact the transformer foreseen for this installation will have 190+10% MVA, and it will work at 140 MW. The EAF will be engineered in order to be prepared for the future installation of a Hot Metal charging equipment, similar to the one installed in Wheeling Pittsburgh; the Hot Metal charge will be implemented by Arvedi, which is considering for that the installation of a dedicated Cupola-furnace of 110 metric ton/h. The new facility will be placed in a complete new building, where additional two LMF also provided by Techint will be supplied. The total production of liquid steel for this new Consteel® system is going to reach 2,150,000 tonnes per year that will increase the total production of Acciaierie Arvedi to about 3.5 million metric tons per year of high quality low carbon steel grades.
Another European plant will put in operation a Consteel® for high quality steel, as started in Europe by ORI Martin, and this plant will be Trier Stahlwerk GmbH, TSW, located in Trier, Germany. TSW has been a historical client of Tagliaferri first and Techint Technologies later. As many other steel Companies in Europe, TSW decided to reconvert its production to quality steel, to change production equipment and to invest in train-

ing and technology. The experience and the success of the Consteel® in ORI Martin, the results of the Consteel® in Wuxi Xuefeng have convinced the shareholder to invest in this proven technology, which will be put in operation during this summer 2007. TSW ordered to Techint a complete Meltshop, including a Consteel® EAF of 60 tons, a LMF and a VD for its production of special steel. Just few month before other two important orders for Consteel® were awarded to Techint. Thep Viet, located in Ho Chi Minh City in Vietnam, ordered a 60 ton Consteel® EAF and a ladle furnace for its new 400,000 ton per year melt shop to be erected in the Phu-My area, and the Greek Company Sovel signed an order for a Consteel® to be added to its existing and already operating 130 ton furnace. In fact this last Meltshop in 1999 was discussing with Techint the possible installation of the Consteel® technology, but probably that kind of decision was not mature. They decided to build a new EAF prepared for the retrofitting of the Consteel® and then eight years later they have completed the job.

Just some years ago, during the Electric Arc Furnace Conference of the I.S.S., held in Pittsburgh, Pa. on Nov. 1999, scrap preheating technologies were expected to increase by a factor of 3, from 10 to 30 % of the newly-built furnaces. The main drivers considered for that were always the same: energy conservation, shorter cycle times and reduced operating costs. What is surprising to many steelmakers, but not to the Consteel® users, is that at that time the major technologies that were considered they would have dominated this market were shaft preheating, with 50% of the installations and twin shell preheating, with 37%. Only "some room" was foreseen for Consteel, up to 5 % from 3 % of 1999. Well, starting from year 2000 it's not been like this forecast was supposing, as nowadays shaft furnaces technology has been abandoned. To tell the truth, already during that Conference in 1999 there was «a strong debate among the experts on the topic of the shaft furnace, which is seen as having already acquired a dominant position, but suffering from a mediocre image in environmental performance, which can only be corrected by expensive abatement measures and restrictions on scrap categories»;(36) Consteel® was expected to be more reliant to these problems, as it has been completely demonstrated.

«The fact that Consteel® results in significant environmental as well as energy-saving benefits is now starting to be crucial for the development of this technology in Europe», says Mauro Bianchi Ferri, Vice President Marketing and Sales for Tenova Metal Making. The reasons for the choice of this technology are always the same: «A Consteel®-charged EAF retains a minimum hot heel of 30% of the steel, compared with a more usual 10 to 15%. This hot heel continuously melts the scrap as it is added to the furnace, which means that the arc is constantly heating the bath and oxy-fuel burners are not needed for scrap melting, thus saving energy», Mr. Bianchi Ferri reported to MBM on Feb. 2007 issue.(37) «The stability of the arc, continuously covered by the foamy slag during the whole process, is consequently cutting flicker, harmonics and noise. The EAF roof remains always closed further reducing energy losses and cutting emissions of gases and other pollutants». The environmental face of the Consteel® system will be now enriched with one of the most innovative products of Tenova, the Goodfellow's EFSOP™ technology, introduced in Canada by Dr. Howard Goodfellow in the late 90s. EFSOP™ is a closed-loop control system that continuously analyses the composition of the off-gases carbon monoxide, carbon dioxide, oxygen and hydrogen and performs the retroaction to the chemical injection system. «This optimises chemical energy use within the furnace, and also detects possible water leakages», explained Bianchi Ferri, «giving a great contribution to safer melting operations».

**Acknowledgements**

We would like to send a huge debt of gratitude to Mr. John A. Vallomy for sharing with us his memories about the Consteel® beginnings, and also to the Companies of ORI Martin, Gerdau Ameristeel, Nucor Steel, Wuxi and all other Companies that believed in this technology. Our deepest gratitude goes to the many employees of all the steel plants whose hard work and dedication made the Consteel® a success.

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