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# NEW WALKING BEAM FURNACE – GERDAU AMERISTEEL MIDLOTHIAN TX[1]

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**Abstract**

Starting back as far as 1997, Gerdau Ameristeel (then known as Chaparral Steel) in Midlothian, Texas (outside Dallas) needed to update their heating capacity in their large section mill. The existing furnace could not meet the production demands of the mill and required a high degree of maintenance to run efficiently and provide a properly heated product to the mill. Most of the existing furnace was demolished including the mechanical handling equipment, skids, steel, refractory, combustion system and controls. Only the understructures mechanism remained. All the equipment and materials were replaced and upgraded. A new 45' section of furnace was added to the charge end of the modified furnace. A new modern Level 1 and Level 2 control and automation system controlled the entire furnace and mechanical equipment. The new furnace was also rezoned to provide better heating quality while the longer and upgraded furnace provided more production, reduced maintenance and fuel consumption.

**Key words:** Reheat furnace; Walking beam; Upgrade.

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**New Walking Beam Furnace – Gerdau Ameristeel Midlothian TX**

Starting back as far as 1997, Gerdau Ameristeel (then known as Chaparral Steel) in Midlothian, Texas (outside Dallas) needed to update their heating capacity in their large section mill. The existing furnace could not meet the production demands of the mill and required a high degree of maintenance to run efficiently and provide a properly heated product to the mill.

Gerdau Ameristeel Midlothian was incorporated in 1973 as a joint venture of Co-Steel International and Texas Industries (TXI Industries). Later Co-Steel sold its share to TXI Industries and just recently TXI sold it to the Gerdau Ameristeel Group. The plant has three mills; a bar mil, a medium structural shape mill and a large structural shape mill. The plant produces about 1.8 million tons of steel a year with the large section mill producing approximately 500,000 TPY. The large section mill produces wide flange structural shapes for the highway, building and construction industries.

Bricmont, Inc., one company of the *Inductotherm Group*, located in Canonsburg, PA (outside Pittsburgh), was selected to upgrade the furnace to increase production, reduce maintenance, provide better heating quality, while minimizing fuel consumption.

While the furnace project was originally labeled an "upgrade", in the end a majority of the furnace was replaced (as new). The project was finally completed in November of 2008. The project delay was a result of a number of project starts and stops due to market conditions (good and bad). Shortly after Gerdau bought the plant, the project was restarted for the third time and completed in late 2008.

Most of the existing furnace was demolished or replaced including the mechanical handling equipment, skids, steel, refractory, combustion system and controls. Only the outer structure and understructure mechanism remained. All the other equipment and materials were replaced and upgraded. A new 45' section of furnace was added to the charge end of the modified furnace. A new modern Level 1 and Level 2 control and automation system controlled the entire furnace and mechanical equipment.

The new furnace was also rezoned to provide better heating quality while the longer and upgraded furnace provided more production, reduced maintenance, lower fuel consumption and lower NOx emissions.

The original furnace was manufactured by Italimpianti and installed in 1990**.** It was a top and bottom fired walking beam furnace with an effective length of 34 feet 9inches and a width of 41 feet. Its rated capacity was 50 STPH while heating a 17in x 12in x 17.5 in beam blank. It was side charged and side discharged via in-furnace rolls. It had 6 zones of control and utilized a regenerative combustion control system. The existing furnace is shown in Figure 1 below.

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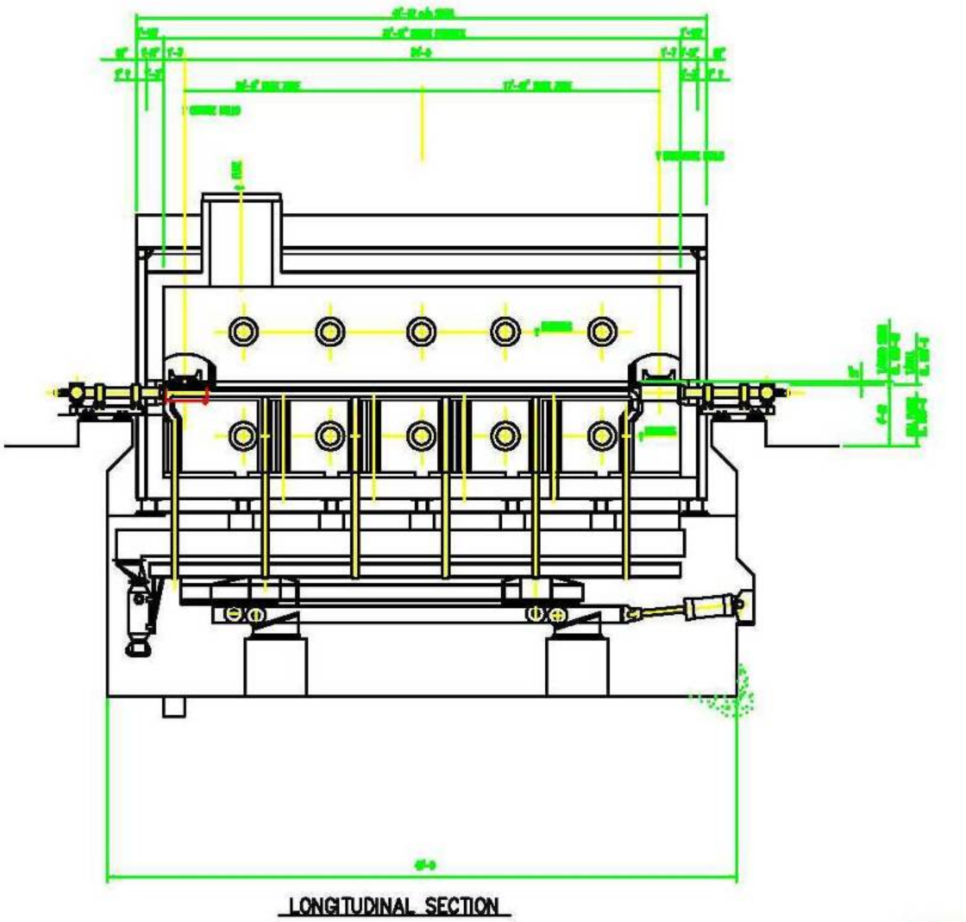


**Figure 1:** Drawing Showing the Side View

- Manufacturer: Italimpianti
- Type: Top/Bottom Fired Walking Beam Furnace
- Dimensions: 34'-9"L x 41' W
- Side Charge – Side Discharge
- Six (6) Zones of Control
- Combustion System: Regenerative (100%)
- Product: 17" x 12" x 17.5' Beam Blank (BB)

The goals of the new furnace were:

- Increase Production (to 100 STPH)
- Reduce Maintenance
- Reduce Fuel Consumption
- Reduce Emissions (NOx)

The modified (new) furnace is a ten zone, top and bottom fired, walking beam furnace. It is side charged and side discharged. The new effective length is 80'-7-3/4". Figure 2 and corresponding data below depict the basic specifications on the new furnace.

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**Figure 2:** Discharge End of New Furnace

- Manufacturer: Bricmont
- Type: Top/Bottom Fired Walking Beam Furnace
- Dimensions: 80.5'L x 41' W
- Side Charge – Side Discharge
- Ten (10) Zones of Control
- Combustion System: Conventional (100%)
- Product: 17" x 12" x 17.5' Beam Blank (BB)
- Level I/II Control

The project scope of work was broken into 2 Phases. The **first phase** was to incorporate the work mainly with the furnace extension as this could be done with out shutting the furnace down. All the equipment supplied and installed in Phase 1 was designed to operate not only for the new extension, but also the upgraded modifications on the existing furnace. The **second phase** incorporated all the work required to complete the tie-in of the two furnace sections and do all design up-grades and repairs to the existing furnace.

The main upgrade to the furnace included an extension to the charge end and upgrade to the combustion system on the existing furnace. A completely new control system would control the entire new furnace. A basic description of the furnace upgrade included the following:

- The extension at the charge end of the furnace added a new top and bottom preheat zone to the overall furnace. This new extension increased the furnace effective length to 80 feet, 7-3/4in. The existing furnace serves as the heating and soaking zones. The new preheat zones are end fired on the top and side fired on the bottom. Each preheat zone is split for east-west temperature control across the furnace width. The new burners replacing the existing regenerative burners are conventional Lo NOx type burners. The total new zones of control are top preheat zone east and west, bottom preheat zone east and west, top heat zone, bottom heat zone, top soak zone east and west and bottom soak zone east and west. The first few burners in the top and bottom preheat zones are sequentially fired for improved heating control.
- A new walking beam mechanism and wheel and ramp assembly was added to the extended furnace. The mechanism consists of a separate lift frame

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(moved by two hydraulic cylinders) and a traverse frame that is link-connected to the existing traverse frame. Although capable of separate lift actions, the lift frames typically operate together and are operated hydraulically and synchronized electronically (via LDT's). The two traverse frames are mechanical tied together and operated with a new hydraulically operated cylinder. The existing wheel and ramp mechanisms were reused on the existing sections of the furnace.

- A new uptake and flue system (including recuperator, dilution air fan, damper and ejector stack) were provided. The new exhaust system was designed to handle the wastes gases of the whole furnace (existing and extension).
- Two new combustion air fans were supplied to provide adequate combustion air to the new burners both in the extension and the upgraded (existing) furnace. Each fan was equipped with a VFD.
- The extension also included a new skid system that was slightly offset and overlapped the existing skid system. This configuration assured a smooth and consistent transfer of heated steel from one skid system to the next.
- The existing hydraulic power system was replaced with a new one to operate the hydraulic mechanical equipment on the modified furnace (existing and new extension). New valving was supplied for operation of the existing furnace lift cylinders.
- The existing cap damper was removed and the opening sealed. All the waste gases from the modified furnace would go through the new waste gas system
- On the existing furnace, all of the side fired regenerative burners were replaced with side fired hot air low NOx burners. These new burners make up the new top and bottom heat zones. The top east and west soak zones contain end-fired burners firing against product flow. The bottom east and west soak zones have side-fired burners. In total, the new furnace has ten combustion zones. After the modification, the installed fuel input totaled 355 MM BTU/hour.
- The existing combustion control system was replaced with a new and updated PLC based combustion control and material handling system and a PC based supervisory control (Level 2) system.
- The existing in-furnace rolls at the charge and discharge end were removed. Ten new redesigned rolls were added at the charge end including new motors and reducers and individually controlled with new VFD units. The discharge rolls on the existing furnace were replaced with ten new redesigned rolls along with new motors, reducers and VFD units.
- The existing MCC, which contained the charge roll drives, dilution air motor starter, and hydraulic power unit motor starters, remained. The VFDs for the new combustion air fans are contained in their own cabinets.
- Refractories were supplied installed for the new furnace extension as well as for the existing furnace along with tie-in sections (roof, side and end walls).
- The extended skid system incorporated the same number of fixed and movable longitudinal skids (with new being in-line with the old). However, the new longitudinal skids utilized the pipe-over-pipe design thus requiring less vertical skids and hence less water and a reduced number of post slots in the extended hearth. The new longitudinal skids in the extension also incorporate hot riders to minimize skid marks on the heated steel. The furnace extension also contained new 304 stainless steel seal troughs and

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blades. These troughs when filled with water and blades seal the slot openings in the hearth to help maintain good pressure control. The troughs are equipped with stainless jet nozzles for scale cleaning. These water jets can be periodically turned on to clean the troughs of accumulated scale.

- A new 3-bank 2-pass recuperator was supplied and was designed and sized to provide adequate combustion air to all the new burners (both furnace sections).
- A bottom baffle wall was added to help segment the zones of combustion control in the heat and soak zones of the existing furnace.
- New long skids and crossovers for the existing furnace were supplied and installed along with new hot riders.
- New skid refractories for replaced skids in the existing furnace were supplied and installed.

The furnace construction presented a number challenges due to restricted access and limited downtime on the furnace. The project was started in 1997 and was completed in November 2008. The project delays were attributed to up and down market conditions. The delays occurred as follows:

| Phase I Contract Signed | Phase I Delayed | Project Restarted (Phase I & II) |
|---|---|---|
| 1997 | 1998 | 2004 |

| Phase II Delayed | Project Restarted (Tie In) | Finished |
|---|---|---|
| 2006 | 2008 | Nov - 2008 |

Figure 3 shows the limited access to add the extension to the charge end of the furnace.

**Figure 3:** Furnace Charge Area – Limited Construction Access

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The charge end of the furnace had to be excavated and undercut so the foundations could be installed and the new furnace extension structure could be tied into the existing furnace structure.
Figures 4 and 5 show the start of excavation and foundation forms.

**Figure 4:** Furnace Charge End Excavation

**Figure 5:** Furnace Charge End Excavation – Foundation Forms

Once the foundations were installed, the new extension was installed.
Once the foundation on the charge end was complete, the furnace extension walking beam mechanism was installed. This work was completed while the existing furnace was still operating.
Figure 6 shows the new walking beam mechanism (lift frame).

**Figure 6:** Furnace Charge End Extension – Walking Beam Mechanism Lift Frame

The remaining part of the furnace installation was hampered due to the restriction of the surrounding equipment and buildings. The furnace structure had to be assembled in modules so large sections could be installed at once. This simplified the installation and saved time and cost.

Figure 7 shows the top preheat burner wall being installed in one whole section.

**Figure 7:** One-Piece Burner Wall Section Being Installed

Once the furnace extension was installed, a new recuperator and ejector stack system was installed along with new combustion air piping back to the furnace burners. This completed the furnace extension part of the project.

Figures 8 and 9 show the recuperator, combustion air piping and stack in place behind the new charge end extension.

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**Figure 8:** New Recuperator and Combustion Air Piping.

**Figure 9:** New Ejector Stack

The entire work on the existing part of the furnace had to be done while the furnace was shut down. This included the burners, piping, skid system, refractory replacement and in-furnace roll table replacement.
Figures 10, 11 and 12 show the old regenerative burners being removed and the new burners installed.

**Figure 10:** Existing Regenerative Burner

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**Figure 11:** Existing Regenerative Burner Being Removed.


**Figure 12:** New Burners Installed

Figures 13 through 15 show the old refractories being removed and the new refractories installed.


**Figure 13:** Old Refractories Removed

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**Figure 14:** New Refractories Being Installed


**Figure 15:** New Refractories Installed

Figures 16 through 18 show the old steel work and piping being removed and the new steel and piping installed.


**Figure 16:** Old Steel Work and Piping Being Removed

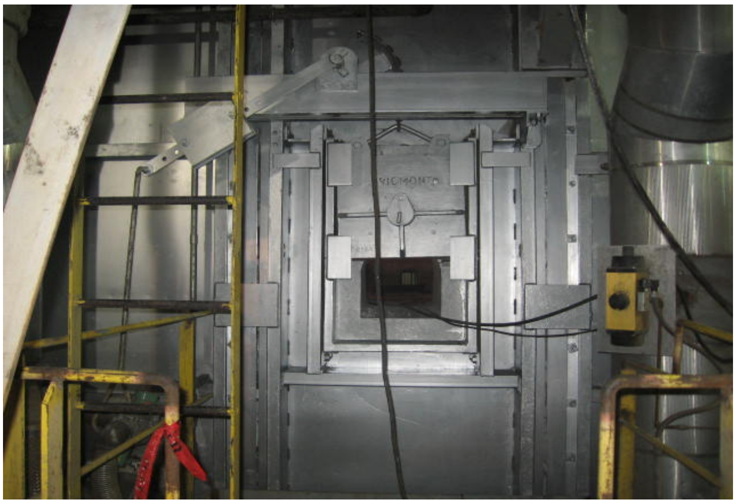

**Figure 17:** New Steel Work Installed


**Figure 18:** New Piping Installed

Figures 19 and 20 show the old in-furnace rolls being replace by the new in-furnace rolls.

**Figure 19:** Old In-Furnace Charge Rolls

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**Figure 20:** New In-Furnace Charge Rolls Installed.

Most of the controls system work was done while the furnace was operating. The removal of the old system and switch over to the new system was done during the furnace outage. New level 0 system was installed, including thermocouples, gas and air control drive actuators, and transmitters. Transmitters were installed on a rack and mounted for easy access. Picture 20 shows the transmitters mounted together for convenient access.


**Figure 21:** Transmitter Mounting

Level 1 was replaced with a PLC/PC control system consisted of Allen Bradley ContrroLogix PLCs for combustion and material handling. A special Allen Bradly PLC served as the safety PLC. PCs located in the mill pulpit served as various HMI's and a PC server was supplied for the level 2 system. The main control configuration is shown in Figure 22. Figure 23 shows the control system furnace overview.

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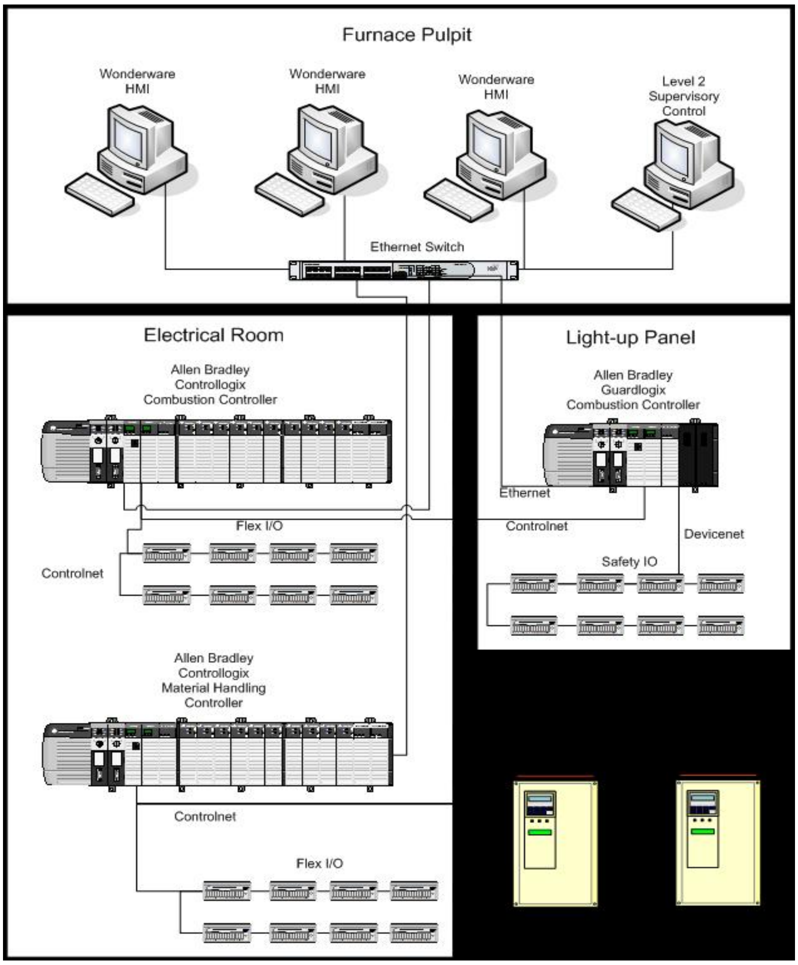


**Figure 22:** Control System Configuration

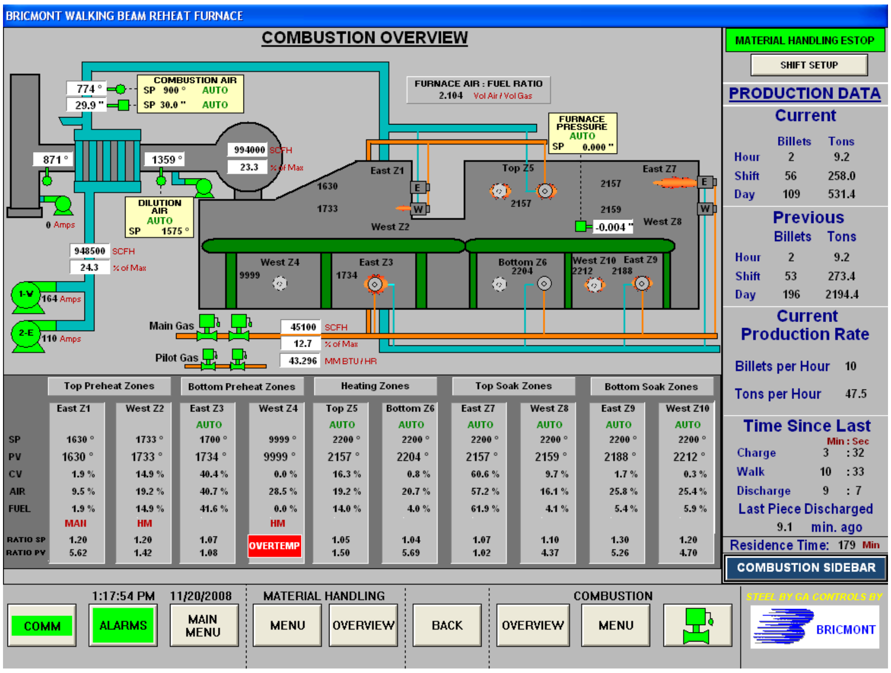


**Figure 23:** Control System Furnace Overview

The entire furnace heating strategy can be optimized as all burners have the capability of being turned on and off by the control system. As the level 2 system determines the optimized furnace temperature profile, the level 1 system turns

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burners on and off throughout the furnace to optimally meet the required heating demand.

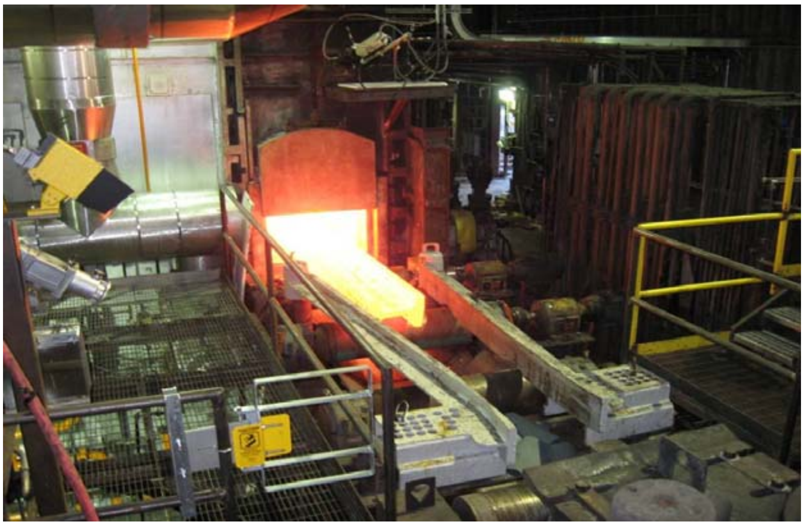

**Figure 24.** First Beam Blank Discharged

**Conclusion**

In conclusion the furnace conversion was successfully completed within the designated time period of 44 days. The production throughput was increased from 50STPH to 100 STPH. The maintenance was reduced as the regenerative burners were replaced with a conventional combustion system and the furnace could be operated with a lower furnace temperature profile thus saving wear and tear on the furnace exterior. The NOx was reduced to 0.09lbs/MMBTUs. The fuel rate was reduced to 1.5mmBtu/Ton (at 90%hearth coverage).