Comprehensive Modernization of the 166-Inch Plate Mill at Algoma Steel

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ABSTRACT
Algoma Steel and Danieli are completing the upgrade of the 166-in. wide plate mill at Sault Ste. Marie (ON), Canada. The complete rolling, leveling, inspecting and cutting processes have been significantly modified from the walking-beam furnace exit down to the plate dispatch area.
The modernization included the complete replacement of the old L1 and L2 automation and tracking system.
The project is in its final stages and when fully implemented will allow Algoma product portfolio expansion with new plate grades, better control shape, surface quality, and improved logistics – making it possible to offer enhanced ship-on-time performance.

DISCUSSION

About Algoma Steel, Sault Ste. Maire (ON), Canada
Established in Sault Ste. Maire (ON), Canada in 1901, Algoma Steel Inc. is a fully integrated steel producer with a raw steel production capacity of approximately 2.8 million tons per year.

Algoma’s cornerstone asset is the Direct Strip Production Complex based on Danieli QSP technology and commissioned in 1997. The DSPC positions Algoma as one of North America’s leading suppliers of high strength and light gauge steel, transforming liquid steel to a finished coil in about thirty minutes.
As part of the transition program from integrated to electrical steelmaking in 2022, Algoma Steel chose Danieli as sole technology supplier for its new green steel shop with a design capacity of 3.7 million tons of liquid steel, featuring two 250-ton electric arc furnaces at its core, and powered by two Q-One digital power systems with a rated capacity in excess of 190 MVA each.

Commissioned in 1963, a combination of plate mill and conventional HSM has been the main production unit of the Sault Ste. Marie facility for many years, enabling Algoma to produce 150-in wide plates and 96-in wide coils.

In 2019, Algoma and Danieli developed one of the most extended plate mill modernization concepts ever implemented, which made it possible to grant the 60-year-old plant new levels of quality and competitiveness for serving the North American market.

Today, Algoma’s size and diverse capabilities enable them to deliver responsive, customer driven product solutions straight from the ladle to direct applications in the automotive, construction, energy, defense, and manufacturing sectors.

**Algoma Steel Inc., Sault Ste. Marie (Ontario, Canada), 166” plate mill comprehensive modernization project**

Danieli, Danieli Automation, and Danieli Taranis are the supplier team chosen by Algoma Steel for a complete upgrade of the 166-in. wide plate mill at Sault Ste. Marie (ON), Canada.

The project will allow Algoma to expand its product portfolio to include new plate grades, to better control shape and surface quality and to improve logistics—making it possible to offer enhanced ship-on-time performance. By means of an extended upgrade and replacement of the existing equipment, the complete rolling, leveling, inspecting, and cutting processes will be significantly modified from the walking-beam furnace exit down to the final plate dispatch area.

The main targets of the Mill Modernization Project are the following: to expand product portfolio by including new grades, at the same time improving surface quality, flatness characteristics and plate shape. Another important improvement area regards the logistics of plates between rolling and finishing areas, as well as plate dispatch, resulting in an overall enhanced ship-on-time performance.

Furthermore, the existing 4-Hi mill stand has been realigned with the introduction of 10-mm offset between work rolls and back-up rolls.

**A PACKAGE DEDICATED TO IMPROVING THE PLATE SURFACE QUALITY INCLUDES UPGRADE OF ALL DESCALING POINTS ALONG THE PLATE MILL**

**Primary Descaler (Picture 1)**

During Phase 1 of revamping, the new advanced one ramp Primary Descaler was installed at the furnace area exit. It’s characterized by the following main features:

- Contains one top and one bottom header;
- While the bottom header is fixed, the top header is automatically adjusted according to the thickness of slab to maintain the impact pressure on top surface independent of slab thickness that varies significantly;
- The pattern of nozzles was selected to increase the impact pressure at level of 1.5 N/mm² to improve scale removal capability at the same time maintaining the flowrate provided by existing Descaler pump unit (max. 370 m³/h).
2-Hi stand and 4-Hi stand on-board descalers
The intervention for the upgrade of the 2-Hi Rolling stand descaler system is planned by May/June of 2024 and for the 4-Hi Rolling stand by October/November 2024.

New on-board descalers for both 2-Hi and 4-Hi Rolling stands will include two ramps each (one at entry and one at exit of the stand). The bottom header will be fixed, while the top header, installed on the entry and exit top guides, will move together with guides, following the change of material thickness together with the top work roll. The average impact pressure will be 0.8 N/mm² with a flow rate of 360 m³/h for the 2-Hi stand and 0.6 N/mm² with a flow rate of 374 m³/h for the 4-Hi stand coping with the available capacity of the existing pump system.

Hot Leveler entry descaler (Picture 2)
Another descaling point is at the entry of the hot leveler. This is a unique feature which is meant to clean the plate surface from all the tertiary scale and avoid scale imprint by the levelling process.

Furthermore the leveler will be safe from the scale buildup given by the bending / unbending process.

The descaler unit has one ramp containing one top and one bottom header. The average impact pressure will be 0.6 N/mm² with a flow rate of 374 m³/h.
All descaling units are designed for operating pressures of 2000 Psi with a future increase up to 3000 Psi, with the installation of the new descaling pump station with pressure increased up to 3000 Psi (206 bar).

The installation of both the Primary descaler and hot leveler entry descaler has already been completed and both descalers and have been already in operation since last year.

Even though the implementation of a complete surface quality package, sourced through OEM Parsytec, is not yet finished, positive results have already been observed. Since the very beginning of the start-up of Phase-1 equipment, surface quality of the output products has visibly improved. The customer’s QA department and machine operators have noticed a marked improvement of surface and flatness and are very pleased with the quality being received as of late.

Rolling stability in 4-Hi stand
The realignment of the 4-Hi Rolling stand, along with the implementation of work rolls offset is planned by May/June of 2024. This work is being undertaken to mitigate issues of camber that are being experienced on lighter gauge material. At the current time Danieli and Algoma are completing the commissioning of camber control function allowing for reliability rolling also light gauges from below 8mm.

Plate flatness improvement by installation of new state-of-the-art hot leveler (Picture 3)
The installation of a modern EVO/4 hot leveler equipped with MultiMoreTorque drive system allowed to significantly enhance the flatness of produced plates in the wide range of thickness from 6 to 88.9 mm. This fully hydraulic leveler, featuring high force HAGC, bending travers, top cassette skewing and tilting, as well as height adjusted entry and exit bottom rolls, allows to create a large pattern of roll gap adjustments covering practically all possible flatness defects, such as edge waves, center buckle, crossbow, etc.
Moreover, the individual drive provided for all 9 levelling rolls ensures the precise control of roll speed and torque of each roll, preventing the appearance of parasite torques often met in grouped driven levelers that can lead to breakage of drive elements (mechanical kinematic chain).

![Picture 3. Hot Leveler](image)

An indispensable addition to the mix, this impressive leveler features a special cassette-shifting system that allows the quick interchange of the bottom cassette with a section of the roller table, to bypass the leveler. This feature proves invaluable when the plate mill is engaged in rolling transfer bars for coil production.

The machine is currently running stable in production for an “Optimization Period”, after which the Performance Guarantees will be proven, with the target of reaching challenging flatness tolerances within ¼ ASTM A6.
Table 13. Permitted variations from a flat surface for standard flatness carbon steel plates

ASTM A6/A6M – 07

Table 14. Permitted variations from a flat surface for standard flatness high-strength low-alloy steel and alloy steel plates, hot rolled or thermally treated

ASTM A6/A6M – 07

Cooling beds and finishing area

The installation of two new disc-type cooling beds operating in parallel was also completed. The advantages achieved with their installation are an improvement of plate-cooling uniformity and productivity, as well as plate tracking and logistics. This is ensured by avoiding intermediate manual plate storage between rolling and finishing areas, maintaining the plate temperature at shear entry below 85°C.

The entire finishing line, along with the new cooling beds, was fully commissioned by the end of 2023 and it is currently ramping-up production, with the target of reaching performances within Q2, 2024.

Dividing shear (Picture 4) with scrap handling system and sampling shear

The improvement of plate geometrical tolerances for length and squareness was achieved with the installation of a new state-of-the-art close-frame and rocking-type dividing shear that was successfully completed. In addition to the precise length cut, the shears are used as a part of an automatic sampling system that was also supplied by Danieli, dedicated to obtaining drawing test specimens to certify the mechanical properties of the finished plates.

The new shear was installed together with a new depressing table, entry and exit roller tables, and plate alignment system.

The shear is able to cut plates with very high tensile strength (up to 1200 MPa for thickness 1.6” and 750 MPa for thickness 2”). The cycle time for one cut is under optimization, with a performance target of being not longer than 8 seconds. Reliability work continues between Danieli and Algoma on the custom scrap collecting system to achieve full reliability.

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Magnetic piler
At the end of the line, to facilitate and improve the dispatching practice, a magnetic piler was supplied and installed by Danieli. The piler is able to handle pieces up to 26 m long and has 4 piling positions equipped with shiftable cars to extract piles from the piler operating zone, compiling the piles with a maximum weight of 25 tons.

Marking machine
New fully automatic marking equipment was installed, to indicate the plate identification data on plate surface.

**ELECTRICAL AND AUTOMATION SYSTEMS**
Danieli supplied the new complete Level 1 and Level 2 systems for both existing and new equipment, covering process and equipment control from re-heating furnace charging tables to plate piler, including interfaces with all the external existing systems (such as gauges, MES L3 and HSM Level 2).

The advanced control systems, along with a new operator interface (including control desks and a Client-Server HMI system), consolidated in a uniform hardware and software automation platform, as well as achieved the integration of all the plate rolling and finishing processes. The technological controls of the edger, two-high and four-high mill stands and hot leveler, as well as logics and control for auxiliary and finishing area equipment, is performed by the same type of PLC (S7-1500), thus simplifying the overall system architecture and improving reliability and maintainability when fully implemented.

The completely redesigned integrated tracking system will allow timely execution of all automatic control actions, including multi-piece thermomechanical rolling and handling of exceptions which will allow Algoma to produce new grades once commissioning of the Batch rolling is completed. Additionally, the new Level 2 system, powered by state-of-the-art mathematical models, ensures accurate set-ups to plate mill equipment, tracks the plates throughout the entire facility, and collects process data for quality reports and long-term archiving.
The new Level 2 system and PLC controllers were installed in parallel with the existing control systems and equipped with specific I/O signal duplication and switching devices allowing a fast switchover between new and existing control systems, with the aim of reducing the risks during the commissioning and start-up of the new systems.

The new supply also includes new plate marking and stamping equipment and an advanced new 3D automatic inspection system for plate top and bottom surfaces, that provides important quality information. The upgrade project also includes new AC motors and gearmotors, drives and transformers for the new equipment, as well as the replacement of old M-G sets with new, digital DC drives for the speed regulation of the four-high stand and side-trimming shear area existing DC motors.

INSTALLATION AND COMMISSIONING

The project has been planned and is currently being executed by Danieli and Algoma steel across two distinct phases:

- During the initial phase of the mill’s revamping process, a range of state-of-the-art equipment was installed and commissioned. At the core of phase one was the integration of a new descaler system, containing two key descaling components: a primary descaler, and a descaler positioned before the hot leveler. Another important part of Project Phase one was integration of the new EVO/4 hot leveler.

Finally, the seamless conversation between Level 1 and Level 2 automation systems when fully implemented will allow for an improvement of product geometrical tolerances, as well as a comprehensive control of the mill.

- Phase two of the mill revamping project consists of the final steps necessary to complete the upgrade. These include a complete reconsideration of the layout of the finishing line, linking together the rolling, shearing, and finishing operations with two new, parallel disc-type cooling beds. Another significant part of Phase 2 implementation is new rocking-type dividing shear together with the integration of a new magnetic piler.

While this paper is being written, Danieli and Algoma completing the Phase 2 modernization activities. At this point all equipment has already been installed and is in production ramp up. Key to the success of the implementation was the coordination between installation and production teams.

New foundations have been realized with almost no interference with plant operating requirements, using bypass bridge tables, installed during regular maintenance shutdowns of the plate mill. Hydraulic and lubrication units have been pre-commissioned in advance. The leveler has been preassembled and tested offline, as well as shifted into its final position during the 28-day outage.

Furthermore, in order to deal with the many challenges posed by the project, new L2 system and L1 controllers will be installed in parallel with the existing PLCs through specially designed I/O interface modules, allowing for a fast switchover between new and existing automation systems.

This approach enabled risk-free testing and commissioning of the new control system and a fast-learning curve after start-up.

CONCLUSIONS

This strategic plate mill modernization project stands as a testament to Algoma Steel and Danieli’s enduring partnership. After so many projects and continued trust and collaboration, Danieli now stands as the technological provider of both the plate and thin-slab coil rolling units at the Sault Ste. Marie Works.
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