

Clean Atmospheric Emissions Reduction (AER) project, Copper Cliff, Ontario

Canadian Consulting Engineering Awards 2019 Category: Natural Resources, Mining, Industry & Energy

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Introduction

In 2012, Vale launched a CAD \$1-billion initiative to modernize its nickel smelter complex in Sudbury, Ontario -- the largest single environmental investment in Sudbury's history, and one of the largest in Canada. SNC-Lavalin provided project management and EPCM services to support construction of two new converters, a wet gas cleaning plant and a new secondary baghouse, along with reconstruction of converter flues. At completion, the smelter decreased sulphur dioxide emissions by 85% and dust and metal emissions by 40%.



Innovation

In order to meet annual emissions of sulphur dioxide (SO₂) subject to Ontario Regulation 194 as well as nickel dust emissions, Vale undertook the Clean Atmospheric Emissions Reduction (AER) Project to address annual particulate and SO₂ emissions, and nickel and SO, ground level concentrations.

Some of the major project designs include the following:

- ⇒ New converters with tighter fitting hoods
- ⇒ New converter wet gas cleaning plant that cleans and conditions off-gas from the converters before venting to the acid plant
- ➡ Complete re-design and optimization of the smelter flue networks;
- ⇒ New large-scale baghouse with two 690,000 cfm / 4,000 HP fans that filter particulates before venting to atmosphere
- ➡ Two new 450-foot stacks.

Custom designs were developed for complex systems and installations since global benchmarks were not always directly applicable. Implementing the new designs also carried inherent risks to metals production since there was little opportunity to prove and troubleshoot designs before entering service. This necessitated engineering designs with increased levels of precision and other provisions such as adaptability to allow for adjustments and fine-tuning in the field.

The converter was one of the larger and more complex custom designs that included the following: \Rightarrow Refractory lined shell with ring gear/pinion drive

- system, trunnion rollers and riding rings
- 🗢 Bustle pipe and tuyere line
- ⇒ Water-cooled primary hood

- Secondary hood with rack and pinion drive system, and
- ⇒ An evaporative spray system.

Computational fluid dynamics (CFD) and finite element analysis (FEA) were some of the tools used to optimize the converter system design and emission capture within the existing building constraints.

Additionally, the off-gas flue network, with sizes ranging from 4 to 20 feet in diameter, is another complex system designed for this brownfield project that required innovative fit-for-purpose designs.

To assist with engineering, a custom in-house application was developed that featured a parametric-based analytical process model to simulate off-gas system performance for various modes of operation. It was one of the key tools used to establish fan and burner performance requirements. Auto-generated flowsheets and gas profile dashboards also supported design optimizations against criteria such as particulate settlement, system losses, and acid mist condensation.

A final challenge in the converter aisle was the reinforcement of the existing building structure. In the converter aisle, 75% of the building columns required piling beneath existing footings. In order to install the piling with minimal impact to operations, the engineering team developed a sequenced installation plan, which enabled continuous building loading to maintain ongoing operations, while underpinning certain of the building's footings to install the piles.



Complexity

The smelter produces 80,000 tonnes of Bessemer matte (molten metal produced during the copper extraction process) annually. One of the greatest challenges of the project was to limit the impact on the Copper Cliff smelter complex's operations and production throughout construction. In the converter aisle where 25% of construction took place, the crew installing the new converter worked directly beside the operating converter. Moreover, approximately 180 daily crane movements of molten metal were travelling along the aisle during this period. The converter was successfully installed thanks to the collaboration and integration of an experienced construction management team combined with a dedicated Vale Operations team. Teams met multiple times per day and schedules were jointly developed to ensure project work was coordinated optimally. Throughout the construction period of

both converters (approximately 30 months), the project had no impact on the smelter's operations.

Another major challenge was the impact of the project work on personnel working in the smelter during crane lifts. Due to the location of some of the major primary and secondary ducting, several of the main walkways, lunchrooms and offices were barricaded during critical lifts. SNC-Lavalin's field engineering team worked closely with the construction contractor to design pre-assembled box structures to reduce the overall amount of lifts required. This allowed for loads of ducting, piping and structural steel to be pre-assembled on the ground and then lifted in larger sections. Lifts were done during lunch or shift changes to limit impact on personnel and normal activities at the smelter.

Social and/or economic benefits

The project boosted the City of Sudbury's economy by creating 550 jobs over a period of two years and provided work for many local suppliers and contractors.

Early on, we identified gaps in local contractor performance during the pre-gualification and technical bid review stage of the project. We moved quickly to establish training programs and requirements with the help of the IHSA to elevate the understanding and performance of contractor supervision through mandatory training. Field staff and frontline tradespeople attended regular meetings with managers, giving them an opportunity to raise any concerns they had. This, coupled with early adoption of working at heights training two years prior to mandatory provincial Ministry of Labour

requirements, helped us improve contractor performance onsite and within their organizations. Similarly, when it became apparent that the local contractors were struggling with a known acid dust hazard, we established clear expectations and PPE requirements that radically transformed their performance in challenging brown field environments with the goal of zero harm and performance results.

The project maintained an outstanding health and safety record during this time. Thanks to the standards and procedures we introduced on the project, the team met all the client's key health and safety objectives.

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Environmental benefits

Prior to the Clean AER Project, about 150,000 tonnes of SO_2 were released out of the nickel smelter's super stack per year. At project completion, 20,000 to 25,000 tonnes are expected to be released annually. This represents a 85% reduction in emissions and makes the super stack obsolete. It will be decommissioned and two 450-foot replacement stacks will be installed. The shorter stacks have been designed to handle a far lower concentration of approximately 25,000 tonnes of SO_2 per year, and will require significantly less natural gas to operate. By turning off the super stack natural gas burners, Vale will be able to cut its carbon dioxide emissions by approximately 40%, thus reducing its overall environmental footprint in the community.

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The lower SO₂ emissions will not only impact the citizens of Sudbury, but specifically the workers inside the Smelter Complex. For instance, in the converter aisle the air was hazy, but the installation of secondary and primary tight fitting hoods now prevents SO₂ gases from escaping into the aisle. This improved air quality will result in a better working environment for the workers.

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As part of the project, a series of baghouse and tight-fitting dust capture hoods were installed in areas of the plant where workers previously were obligated to wear respirators. Today, workers can enter these areas without being exposed to airborne nickel dust particles.

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Meeting the Client's Needs

Our client's project goals were to comply with the 2015 Completed in September 2018 and over five years of annual emission limit targets and provincial offsite air quality construction work, the project reported no environmental regulations by implementing the best available control exceedances and no impact to the local community. technologies at the Copper Cliff Smelter and operations, all Additionally, the project team developed a series of safety tools and training programs that were essential for the successful and on-time delivery of the project. A few of the measures introduced to the project include Pre-Mobilization risk assessments, close-fitting eye wear, intensive field audit programs and proper training for all supervisors. As a result, several local contractors adopted these tools as the "new norm" to improve the way they work.

the while maintaining operations and production levels. Vale also clearly set out to complete the project with no harm to employees, environment, communities or other stakeholders. By reducing SO₂ emissions by 85%, our client can continue to operate the smelter without having to shut down due to environmental exceedances, which had previously frequently occurred in summer months.

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