

XPS Offers Multi-Disciplinary Expertise

XPS prides itself on being a leader in Process Mineralogy, Process Control, Materials Technology and Extractive Metallurgy consulting, lab and pilot plant services. Along with being a leader in each discrete area, XPS offers a multi-disciplined approach to meet our clients' challenges in plant optimizing and flowsheet development...all in the pursuit of value creation.

Seldom is this more obvious than now, where much of our business is in the area of plant support and installed process optimization which rarely requires a single skill-set.

The process objectives of throughput, product quality, yield or a combination could be challenged by ore mineralogy, hardness, or complexity, lack of measurements or controls, poor plant operating availability due to unplanned failures or downstream constraints related to impurities or other diluents.

XPS offers these complete services to address these objectives all under "one roof". For example, the process mineralogy group can work with mine or exploration geology and mineral processors to define the geomet units using advanced quantitative mineralogical tools such as QEMSCAN and Microprobe. Once the mineralogy is understood the mineral processors, laboratory technicians and process control engineers can test and define process parameters, measure and automate to achieve the objectives defined by product targets. Extractive metallurgists can model the process constraints and look for alternatives to maximize value downstream of the mill while our materials engineers can define strategies to reduce wear, corrosion or a combination to achieve operating availabilities and maximize value of installed assets.

XPS brings decades of experience to our clients with, when required, a multi-disciplined approach to problem solving. This is one of our major strengths that we see more and more in demand.

XPS is into Training!

XPS is offering a pumping course highlighting operating and mechanical maintenance fundamentals of industrial pumping systems. The course is being delivered by expert Larry Bachus, "The Pump Guy", and is being held in Sudbury in September this year. The course description and logistics are highlighted on the back cover of this XPS Bulletin. Please contact us if you are interested in attending.

XPS at Conferences!

XPS plans on attending and presenting technical papers and plenary sessions at several conferences in the next few months, specifically, AusIMM Mill Operators Conference in Townsville, Australia, and MetSoc in Vancouver in September, 2014 followed by the IMPC in Santiago, Chile in October. We look forward to seeing our past, present and future clients there so we can discuss these integrated and multi-disciplinary set of skills and expertise.

In the meantime, we hope you enjoy the selection of articles in this edition of the XPS Bulletin.

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Eagle Project's Humboldt Mill in Marquette County, Michigan

The Eagle Project: Developing Michigan's First Nickel Mine

The year 2014 will represent a significant milestone for Michigan's Upper Peninsula with the commissioning of Lundin Mining Corporation's Eagle Mine. The Eagle Mine will represent Michigan's first nickel mine, and the first mine in the United States in which nickel is the primary metal rather than a byproduct. Average production is expected to be 23 ktpa of Ni, 20 ktpa of Cu, plus PGM and cobalt credits over the mine's first three years of full production.

XPS' history with the Eagle mine dates back some years, when a former owner contracted XPS to develop toll milling options for the ore. Lundin's decision to refurbish the nearby Humboldt Mill in Marquette County resulted in a new round of flowsheet confirmation and piloting, in which XPS was happy to participate. Development work at XPS included both batch testing and



XPS Mini Pilot Plant (MPP) Flotation Unit

continuous piloting in the XPS Flotation Mini Pilot Plant. The pilot plant, which was operated at approximately 12kg/hr, produced a bulk CuNi concentrate at grades over 22% Cu+Ni in concentrate. The pilot plant produced scale-able operating results requiring only about 300 kg of ore per operating day. This low quantity of sample is a big advantage as the cost of acquiring ore sample is significantly lower with the XPS Mini Pilot Plant versus conventional pilot plants.

The pilot operation employed the new XPS Laboratory Information Management (LIMS) system which in combination with rapid laboratory XRF assays allowed the construction of materials balances one hour after sample collection, at a frequency of one sample set per three hours. With this level of information feedback the stabilization of the pilot operation was so rapid that XPS succeeded in fully meeting the project objectives within a day and a half from startup, and was able over the four day pilot campaign to test and stabilize two flowsheet alternatives above and beyond client expectations.

The bulk piloting campaign was followed by a Cu-Ni separation campaign using accumulated concentrate, in which samples of final Ni and Cu concentrates were produced for testing and marketing evaluation.

XPS is continuing to work with Lundin Mining Corporation on pre-startup refinement of the metallurgical recovery model and is looking forward to providing on-site plant support as this landmark nickel project proceeds toward successful start up and commissioning. XPS will be offering multidisciplinary on-site support to Lundin Mining Corporation's Eagle Project in the areas of metallurgical diagnostics, determination of optimum operating conditions, process control and loop tuning, and materials technology.

Contact Gregg Hill at gregg.hill@xps.ca for further information on the use and availability of the XPS Mini Pilot Plant and related capabilities.



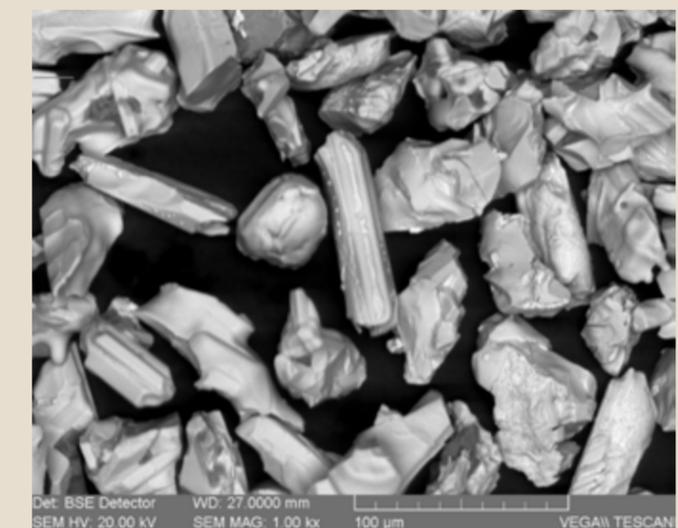
CuNi Bulk Rougher Concentrate from Eagle Ore

KWG Resources Innovative Ring of Fire Chromite Processing

XPS continues to develop the technology for an innovative solid state chromite reduction technology as an alternative to energy intensive smelting.

In the new process, chromite ore is reduced in its solid state to metallic ferrochrome carbide instead of high temperature smelting in a conventional arc furnace. A proprietary catalyst reduces the temperature and increases the rate of chromite reduction. This reduces the energy consumption and process complexity. Natural gas, readily available in Ontario, is used to replace electricity as the primary energy source, further reducing production costs. Simple physical upgrading of the product at room temperature produces a high grade metal powder as seen in the accompanying photo.

The technology development is continuing with larger scale tests. KWG Resources is planning for a larger scale sample to be extracted to allow for process piloting later this year.



Samples of high grade ferrochrome carbide (>60% Cr) produced via the innovative route

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Production of Low-Silica Copper Concentrates for Mopani Copper Mines

Control of non-sulphide gangue in copper concentrates is important for copper operations, especially those that rely upon downstream pyrometallurgical treatment. Optimizing the quantities and ratios of sulphide and non-sulphide diluents can reduce the pyrometallurgical energy requirements, as well as maximize smelter throughput.

Mopani Copper Mines (MCM) operate in the Zambian copper belt and recently engaged XPS to develop a process for reducing the levels of silica gangue in copper concentrate from the Nkana concentrator. A key deliverable of the project was the assessment of the potential benefits of mechanical entrainment-free flotation such as might be experienced from a device such as a commercial Jameson™ cell.

Assessment of entrainment-free devices on a batch laboratory scale is sometimes challenging, since laboratory devices cannot accurately replicate the dynamics of commercial-scale froth washing. XPS uses a low-density multi-stage laboratory cleaning protocol that accurately replicates on a laboratory scale the commercial results of froth washing.

The laboratory program demonstrated the benefits of a combination of fine regrinding using IsaMill™ and froth washing technologies, allowing SiO₂ in final concentrate to be reduced from about 15% to below 5% at equivalent recovery. Mineralogical assessment of the concentrate using QEMSCAN showed the

largest benefit to be seen in the slimes (<3µm) fraction of the ore, which improved from 34% SiO₂ (plant) to ~5% SiO₂ (steady-state locked cycle in laboratory). In the entrainment-free laboratory float the grade of SiO₂ in the finest fraction of the concentrate was the same as that seen in the intermediate size fractions, with the only elevation in silica observed in the coarsest (locked) particle sizes. Consequently the low density multi-stage cleaning protocol allowed the laboratory replication of steady state recoveries in an entrainment-free environment.

The accurate laboratory replication of commercial zero-entrainment devices such as Jameson™ cells is an important achievement, since it allows the simulation and scale-up of laboratory-based cleaning results, as well as the accurate projection of performance in situations where phenomena other than entrainment much be considered, such as fine mineral association or the presence of floatable silicate components. This will be the focus of the next round of work on Mopani future ore, in which the cleaning work will assess the potential role of dispersants and depressants upon concentrate quality from ore zones containing talcose silicate contaminants.

For further information on this laboratory assessment of this combination of technologies, please contact Gregg Hill at gregg.hill@xps.ca



Commercial Jameson Cell with Froth Washing



Low-density Rougher Float of Nkana ore

XPS Assists in Optimizing Barrick Goldstrike Roasting Conditions

Barrick's Goldstrike operation is one of the largest, lowest cost and most profitable gold operations in the world. They have achieved this success through a program of continuous improvement and technology leadership.

XPS recently completed a program of work that demonstrated that the productivity and efficiency of the Goldstrike roaster operation can potentially be improved through optimization of the operating parameters. The program of work started with test work with 50 mg samples using the XPS TGA. (Thermogravimetric Analyzer) The small scale allowed for numerous roaster conditions to be evaluated including temperature and oxygen enrichment.

Subsequent piloting testwork using the XPS 4" diameter fluid bed roaster confirmed and demonstrated the results from the TGA and allowed us to vary parameters without disrupting the commercial operation. The program of work was a team effort led by Barrick Technology out of Toronto with collaboration with Gold Strike operations and XPS.

Please contact Mika Muinonen, Manager XPS Extractive Metallurgy at mika.muinonen@xps.ca to enquire about XPS' modeling and metallurgical testing services.



XPS Thermogravimetric Analyzer (TGA)

XPS Assists Barrick with Transition to New Technology

Another example of successful collaboration between Barrick Technology, Goldstrike operations and XPS was recently completed.

Barrick Goldstrike are in the process of transitioning from cyanidation for gold extraction into an alternative lixiviant. The new process will produce a different product, requiring some modifications in the downstream processing. Compatibility of the new process with the existing smelting operation was tested in advance using the 30 kg capacity induction furnace at XPS to identify potential hazards which could arise from the modified process. Prior to performing the tests, careful simulations of the expected reactions were performed using the NSERC award winning Factsage™ suite of thermochemical modeling tools including the new phase diagram module to predict



Smelting of EW residues in the induction furnace

the expected outcome. The Factsage model was accurate in predicting thermodynamic results and further reinforces XPS's capability in modeling prior to testwork.

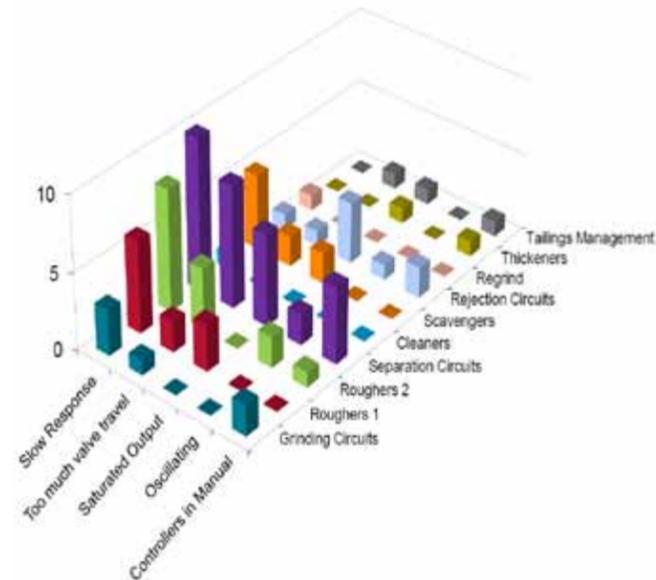
Please contact Mika Muinonen, Manager XPS Extractive Metallurgy at mika.muinonen@xps.ca to inquire about XPS' modeling and metallurgical testing services.

'Maintain the Gain' with Honeywell's Controller Performance Monitor

Process Automation is an essential component of any modern industrial plant. The gain achieved by a well designed and efficient Automation System to strategically control a process is significant. However, in the same way a pump's performance can decline without proper maintenance, an Automation System's performance can deteriorate over time. An Automation System is comprised of control loops, some simple PID, some with more complex logic. Poor control loop performance poses tangible losses to the plant's performance (e.g. throughput, variability, product quality, safety, maintenance costs etc.). Hence, in order to 'maintain the gain' offered by good control solutions, control assets must be closely monitored to ensure that they remain reliable and efficient (Jin, X. 2012, and Ruel, M. 2010).

The XPS Process Control Group recently setup a trial of Honeywell's Controller Performance Monitor (CPM), powered by Matrikon, to assess its suitability to manage control asset performance of an operating concentrator. CPM is a condition-based application that monitors, identifies and remedies control asset issues. The CPM evaluation used six-months of historical data through PI to calculate different Key Performance Indicators (KPIs) such as service factors including the number of controllers in manual, controller oscillation indices, controller output saturation, valve stiction, non-linearity, set-point activity, valve travel, response time etc.

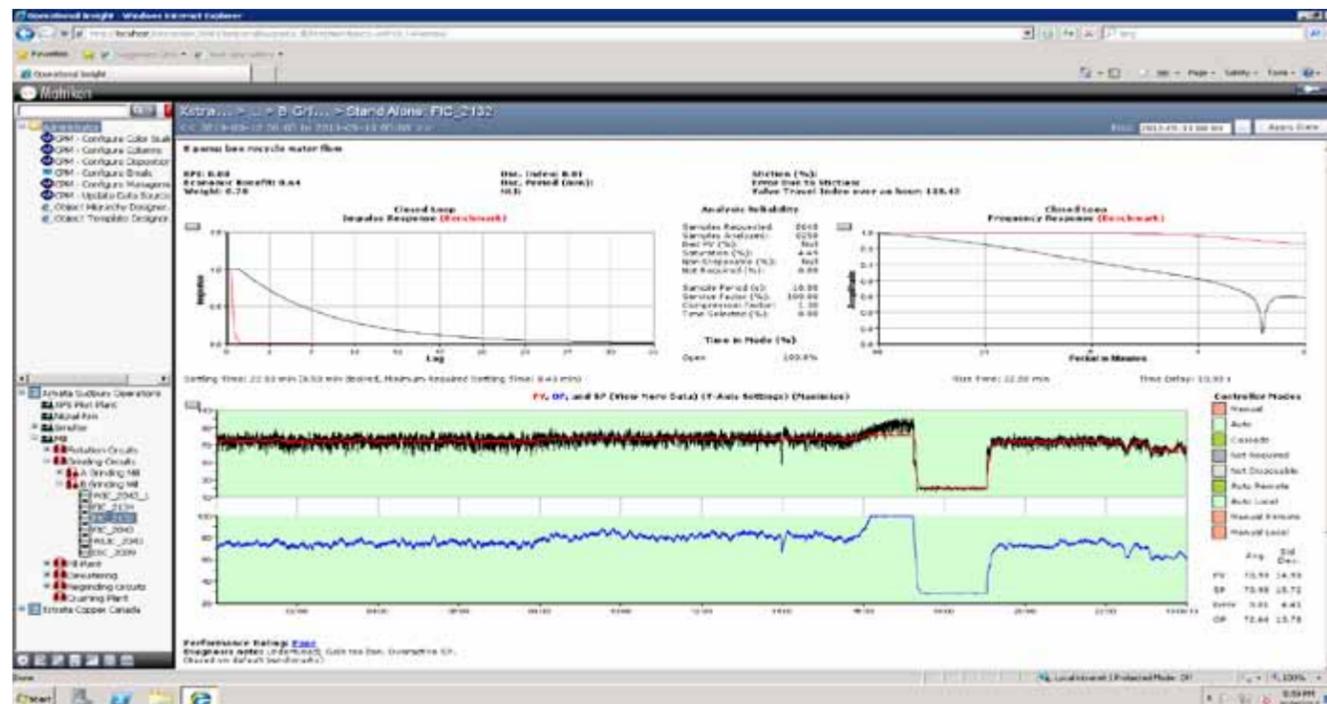
The results of the evaluation showed that the concentrator had 7% of its controllers in manual, compared to the industry average of 20%. None of the valves had 'stiction' or significant non-



Controller performance overview of the Concentrator

linearity issues. Only 3% of the controllers were found to have oscillations. However, 19% of the controllers had slow response compared to industrial benchmarks. Almost 11% controllers had a high valve travel index which implies greater valve wear and tear and about 9% of the controllers had a saturated output for much of the trial period.

Typical CPM Operational Insight page for a controller



For a process control engineer, the CPM eliminates the 'drudgery' of data collection, data preparation, and analysis. However, in order for the CPM to be effective, control engineers must use the presented data in an effective manner and make efforts to integrate the CPM with existing maintenance work practices and the organization's workflow.

Following the evaluation, independent investigation of each controller has started including control strategy verification, operating strategy verification, instrumentation checks, calibration checks and piping checks. After going through the KPIs determined by CPM, and a thorough investigation, it was simple to determine the root cause for each controller issue. An example of a controller flagged by CPM is shown above. The controller had a very high set-point activity and a slow response - as indicated by CPM, and on further investigation it was found that the 'master' controller of the cascade loop was tuned faster than the 'slave' loops. This resulted in slower response of the 'master' controller and also bad disturbance rejection. Proper tuning and instrument calibration resulted in a 65% reduction in the standard deviation in the 'master' controller process variable, and an 85% reduction in standard deviation of the slave controller's process variable, benefitting operations and process performance.

CPM is a very powerful tool, helps quickly determine issues impacting on daily plant performance and in many cases also offers predictive capabilities. Once the controllers are configured in the CPM, the analysis should be performed on a regular basis. CPM saves time collecting data and conducting analysis, provides tremendous analytical information which helps pin point issues to keep the Automation System operating effectively and efficiently.

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Furnace Integrity Monitoring – Patent CA 2469975 Issued

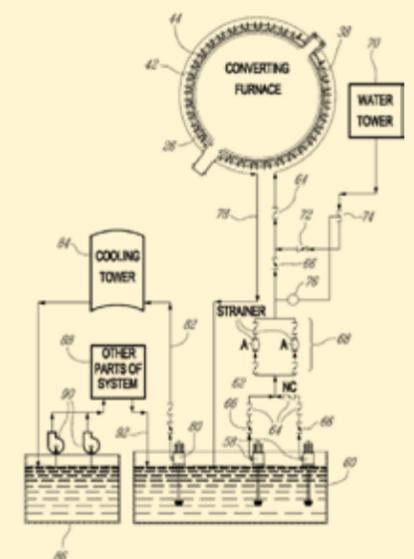
Metallurgical Smelting furnaces, including induction, arc or flash furnaces are amongst the most critical of process equipment items for many metallurgical treatment facilities. Furnaces are seldom installed with redundant backup units, and a premature furnace failure generally means loss of cash flow for the business, increased re-build cost and hazardous conditions for the operators. Furnaces are expected, and designed to perform safely and reliably, with high productivity, under arduous conditions for extended periods, so the overall integrity of the furnace is of vital importance to all stakeholders including owners, operators and insurers.

The XPS Process Control Group, has accumulated several years of experience in monitoring metallurgical furnaces and can assist clients with reliable techniques to confidently monitor critical aspects of furnace integrity. In our experience the following two issues are of critical importance in minimizing the likelihood of furnace failure:

- Monitoring of the refractory lining integrity in general.
- Monitoring of the integrity of tapholes and the areas adjacent to tapholes.

For more information on Furnace Integrity Monitoring, please contact Phil Thwaites, Manager, Process Control and EIT Program at phil.thwaites@xps.ca

On Sept. 17th, 2013 Glencore, was issued patent # CA 2469975 titled: "System and Method for Furnace Monitoring and Control." The application was filed in June of 2004 and was opened to public inspection in Dec. 2005. The patent's abstract is as follows: "The present invention provides a system and method for monitoring the integrity of a furnace containing molten material and giving a prior warning of a potential breakout or process equipment condition using multivariate statistical tools. Multiple multivariate models are used in combination to provide status of the process and deal with long term process drift. The various model results are then used in conjunction to arrive at a conclusion, which indicates the system allows for automatic halting of the process in order to prevent a catastrophic failure of furnace integrity."



Koniambo Nickel SAS: Process Control and Automation Support



Koniambo Nickel, a joint venture between Glencore and Société Minière du Sud Pacifique (SMSP) is in the process of transitioning from commissioning to operation. The ramping up of the two production lines of the metallurgical plant, refinery, and a 350 MW Power Plant requires a great deal of expertise in engineering and management. XPS Process Control Group had the opportunity to take part in this task. Over the past year, XPS has provided process control and auto-mation support and consultancy which includes embedded process control engineers onsite working with the Koniambo Nickel automation and process control group and the commissioning team. The onsite assignment in a beautiful South Pacific island began at the time when the project team just finished commissioning the first production line. The production lines are based on the Glencore-developed Nickel Smelting

Technology (NST) which incorporates cement-plant equipment (Hammer Mill Flash Dryer and Flash Calciner), a Fluid Bed Reducer and DC arc furnace. The technical challenges were mainly around commissioning and ramping up of the production lines to its designed output of 60,000 tonnes nickel per annum.

The onsite role provided the opportunity to contribute in various sectors such as open arc DC furnace power control, grid power fluctuation reduction, process variability reduction, and optimizing plant's control loops. In the initial run of the DC furnace with a high load to the onsite power plant, power fluctuation was technically challenging. Successful contributions were made in overcoming this difficulty by power rectification tuning and optimized electrode regulation. Significant improvements were made in reducing variability in furnace feed and hammer mill dryer circuit draft control from our experience and

understanding of interacting systems and control loops. Together with the process information management team, we have developed an SMS and email notification system for production monitoring in OSI Soft PI system.

New Caledonia is one of the world's more beautiful islands with extraordinary landscapes and biodiversity, and approximately 15% of the world's total nickel reserve. Koniambo Nickel is seen as keystone participant with local stakeholders in extracting value from this valuable deposit while preserving New Caledonia's natural environment. XPS Process Control Group takes pride in contributing to the success of Koniambo and looks forward to continue working with the Koniambo and Hatch teams.

Kabir Ahmed
Project Metallurgist, Process Control
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Mika Muinonen, XPS Manager Extractive Metallurgy, Phil Nelson (Dr. Phil), Chief Process Control Engineer, XPS Process Control and Mark Badyoczek, Manager Technical Services, Luilu Refinery, KCC

XPS Assists with Kamoto Copper Company Roaster Commissioning

XPS assisted with the successful commissioning of Kamoto Copper Company (KCC) new #5 copper sulphating roaster in the Democratic Republic of Congo in March. With the successful commissioning of this roaster, KCC is well positioned to continue to increase copper and cobalt production at their Luilu refinery.

As part of the support work, XPS generated a metallurgical simulation to define the best operating window in terms of feed density and concentrate grade to maximize roaster productivity. In addition, an operating philosophy that maximizes throughput while simplifying operation was specified. The operating philosophy separates throughput control from metallurgical control. An audit of the key process measurements and control loops noted installation and commissioning issues with the off gas oxygen, feed density and roaster air measurements.

KCC achieved a very high roaster on line time of 98% through the month of April. XPS continues to stay in contact with KCC as they prepare for the next phase of optimization of the plant and process.

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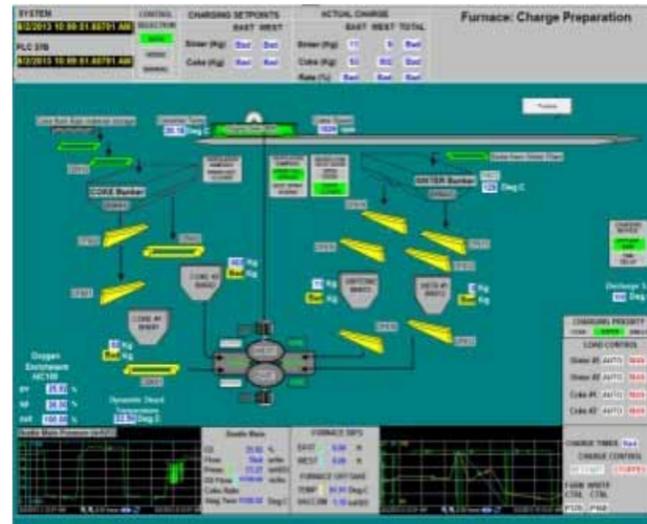


Brunswick Smelter OSIsoft PI (Production Management Information System) Development

The OSIsoft PI System is widely used in the mining industry for real-time process monitoring aimed at maximizing asset performance, mitigating risk, and ensuring regulatory compliance. Many of Glencore's operations in Canada and around the world have been using PI for many years. In November 2013, the Brunswick Smelter joined the list of Glencore PI users when its PI Server 2012 was commissioned.

The previously installed system at Brunswick is based on InSQL and data processing, visualization, system monitoring and is done with ProcessView, a custom developed Visual Basic program based in Excel. Danny Godin, Manager – Zinc IT, who oversees IT infrastructure at the Brunswick Smelter, asked an XPS team, lead by Phil Nelson along with Naseeb Adnan and Alison Cummings to conduct a demo for the Brunswick Smelter team.

Brunswick Smelter - New PI ProcessBook Display



Following the shutdown of the Brunswick Mine in 2013 a PI license became available, which was transferred to the Smelter for developing and installing the PI system. In August 2013, the XPS Process Control team successfully conducted a demonstration of PI using actual data from Brunswick Smelter operation illustrating PI's benefits, e.g., standardization, support, speed, capabilities etc.

In November 2013, I moved to Bathurst and the Brunswick Smelter to lead the configuration of the PI system. This was truly a challenging and exciting project. The smelter had been in operation for many years and most employees were very familiar with the ProcessView System. I had to ensure the transition from ProcessView to PI did not interfere with any current activities. All necessary and required information had to be reproduced or improved upon in PI. Federal and Provincial regulations were carefully considered, and most importantly people from all levels of the organization were included throughout the transition. I attended production meetings, visited the control room

and exchanged ideas with operators to better understand their perspectives and needs were highlights of the project. Over sixty four people were trained on how to use, develop, maintain and troubleshoot the new PI system.

This was an great opportunity to develop a system from the ground up. The scope included configuration of approximately 4,000 tags, 40 odd ProcessBook displays, new OPC interfaces (TopServer), system administrator functions during the project, and finally a handover to a well-trained team. The PI development project has significantly improved the reporting process replacing numerous calculations with performance equations, reducing hours spent preparing month, or yearend, reports and creating new opportunities of asset monitoring.

An important part of the project was rebuilding the Environment Monitoring System (EMS) in PI. Robert Butler, Superintendent, Environment, at the Brunswick Smelter, has provided his feedback on completion of the EMS program for his department,

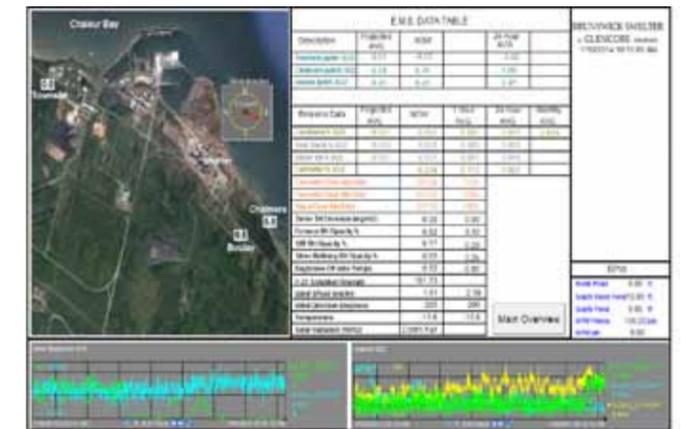
"...a quick review of the value from PI is in the order of \$20K per year, this will not be true savings but it will allow us to focus on other valuable tasks. However, the most significant value, which is cost avoidance in environmental fines, is having a reliable EMS data management system. If the current EMS system fails, the fines start at \$30K per day and each day of non-compliance is a new offence and the fines can double with each consecutive offence."

"Our reputation and integrity with government agencies will only be supported with PI and this will be critical in coming months."

The PI system development project with the Brunswick Smelter team was an extraordinary experience as I was exposed to project management, working with fellow engineers, operators and supervisors, and also got to experience the winter in the Atlantic coast!

Naseeb Adnan, Process Control EIT
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Brunswick Smelter – Environmental Monitoring System (EMS) Display



Dining for the Cure



XPS Director, Dominic Fragomeni, recently participated with other local business leaders, politicians and media figures in the Miners for Cancer dinner as a Sud-lebrity server. The Miners for Cancer organization is entirely volunteer and since 1996 has raised critical funds for patient care, equipment and vital research in Northern Ontario.

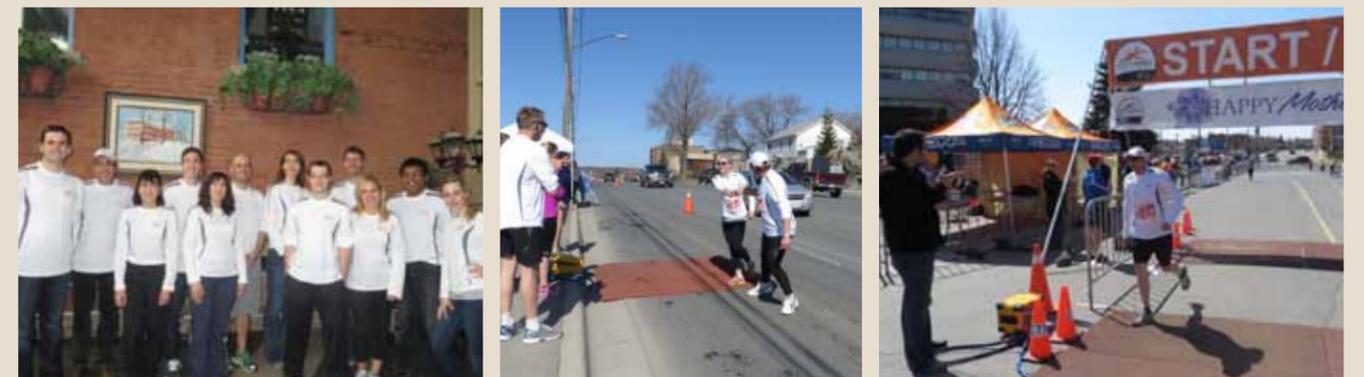
The event was held on April 30, 2014 and featured Chef David Adjey and his culinary team. XPS was glad to participate and contribute to the success of over \$20,000 raised for this worthy cause.



Sudbury Rocks Marathon Relay

In early May, XPS fielded two (8 person each) relay teams for the annual Sudbury Rocks Marathon relay event. Participating in white 'XPS / Glencore' shirts, and blessed with an awesome spring day, over 2000 people participated in this event, raising money for the Canadian Diabetes Association. 'Glencore XPS Won' team were second overall in the team event, with an

(awesome) average time of 4:34 per km and 3:12:21 total against the winner's total time of 3:11:55, and average of 4:33 per km! The following sums it up from one of the participants: "Since my husband lives with diabetes, I'd like to say a special thank you to everyone for raising funds and bringing awareness to what can be a truly devastating disease."



Operation & Maintenance of Industrial Mine Pumps

- Course Instructor:** Mr. Larry Bachus
- Course Duration:** 4 days
- Learning outcomes:** During this comprehensive 4-day course, participants will get the opportunity to review fundamental pump principles, pump cavitations, understand pump and motor alignment, be able to enhance knowledge on bearings, mechanical seals, be able to perform failure analysis of mechanical seals and some common pump problems. Good and bad piping and pumping practices will also be presented during the course.
- A good fit for:** Operations & Maintenance personnel, Maintenance Supervisors, Reliability Engineers, and Mechanical Engineers.
- Sample course content (not a complete list):**
- Basic Pump Principles
 - Pump and Motor Alignment
 - Bearings
 - Mechanical Seals
 - Pump Shaft packing
 - Failure Analysis of Mechanical Seals
 - Avoiding wear in pumps
 - Common Sense Failure Analysis
- Course takeaways:** presentation materials, a book by Larry Bachus (“Everything You Need to Know About Pumps”).
- Course Fee:** **CDN \$2,450.** The course fee will cover breakfast and lunch.
- Course Dates and Location:** **September 15th – September 18th, 2014.**
Willet Green Miller Centre - MIRARCO - Ground Floor Auditorium,
935 Ramsey Lake Road, Sudbury, ON P3E 2C6
- Registration:** Seats are limited, so please register as early as possible.
Please send an email to Tara Rana at Tara.Rana@xps.ca to get registered for the course. Please identify account code or alternative method of payment in the email.