



## Overview

**Country or Region:** Queensland, Australia

**Industry:** Metals and Mining

## Business Situation

QNI faced an unavoidable need for major improvements in process software and control equipment. Replacement costs for QNI's complex facility were in excess of \$1 billion. QNI needed a high-performance IT infrastructure to standardize on an overall operations approach, maximize existing plant output, improve work processes and efficiencies, reduce waste, and meet customer expectations.

## Solution

The PI System™ provides an integrated product family that makes critical, actionable operations information visible across all levels, enterprise-wide.

## Benefits

- Real-time quality measurement results ensure high-quality cobalt production
- Achieved 9001 certification Quality Assurance/Six Sigma goals
- Minimized downtime
- Automatically generated maintenance notifications in SAP
- Validated production information; verified data quality; monitoring and reporting of exactly where losses occur; calculation of monthly reconciled recovery
- Reduction in total steam consumption

## QNI uses the OSIsoft PI System to control refinery operations and gain 41 percent IRR in 3.5 years



"We've used the PI System to benefit our operations in many ways — from tracing product quality to justifying Six Sigma process improvement projects. The PI System has accomplished more than we set out for it, and we've easily achieved an initial rate of return (IRR) on our investment within three and a half years."

Dave Hunter, Group Leader of Metallurgical Accounting, QNI

Until a few years ago, QNI's cobalt/nickel refinery in Yabulu, Australia, used manual process-recording methods. Process engineers found it difficult to determine the influence of variables on product quality, and to generate timely reports for management. Management was frustrated by the challenges of accounting for monthly reconciled recovery, determining where losses occurred, and tracking quality by batch.

To gain control over its operations and processes, QNI needed to track key performance indicators (KPIs) and overall equipment effectiveness (OEE). Though QNI already had a functioning ABB distributed control system, it couldn't store process data for more than three weeks — not really long enough to track production records and monitor KPIs. Faced with ISO 9001 compliance and the need to implement Six Sigma in its manufacture of high-grade nickel and cobalt products, QNI chose OSIsoft's solution to combine production data from its six business units with their total of eight separate control rooms.

PI allows QNI to align products with specs, meet ISO 9001 quality assurance requirements, begin Six Sigma projects, and — best of all — pay off the capital and engineering costs of the PI System in 3.5 years. The system tracks KPIs and OEE, reduces scrap and risk, and stores shift logs electronically rather than on paper. It tracks plant operating conditions required for ISO 9001, warns operators when process conditions vary from setpoints, and lets management proactively resolve potential problems.

## QNI

QNI is involved in the exploration, mining, processing and marketing of high quality nickel and cobalt. QNI's Yabulu Refinery, near Townsville in North Queensland, Australia, processes ore from New Caledonia, Indonesia, and the Philippines to produce high-purity nickel and cobalt products that are used in the manufacture of stainless steel, specialty steels, alloys, and chemicals. Its operations in Australia and Colombia make it the world's fifth largest producer of nickel and one of Australia's largest cobalt producers.

Approximately 3.6 million wet tonnes (3.97 million tons) of lateritic ore are processed annually, ultimately producing 32,000 tonnes (35,000 tons) of nickel and 2,000 tonnes (2,205 tons) of cobalt. Established in 1974 to process ore from the now-depleted Greenvale nickel deposit 140 miles to the northwest, the refinery recently recognized the need for major improvements in software and control equipment used in its processes. Starting over with a "greenfield" approach was ruled out, since replacement costs for such a complex facility would run to more than \$1 billion. Therefore, it became necessary to maximize existing plant output. The risk, however, of under-utilizing refinery assets could result in a significant loss of opportunity.

In addition, the high cost of importing and drying wet ore from overseas together with a rising Australian dollar made it ever more urgent to squeeze out the highest-quality cobalt and nickel from the process with minimal wasted energy. Getting the product quality right the first time was vital to avoid wasting valuable energy and raising operating costs. The company is also firmly committed to the community's health and safety, and to the environment. This commitment mandates tight process controls and an effective tracking system to guarantee product quality, process efficiency, and environmental accountability.

In line with continuous improvement initiatives, the company implemented a production information management system (PIMS) over a two-year period. PIMS initially installed OSIsoft's PI System (PI) in November 2000. The PI real-time, time-series data engine has enabled the facility to make long-term historical process data available indefinitely, rather than for three weeks — the former limit for the plant's existing distributed control systems (DCSs).

The PI System builds on PI by providing an integrated product family that makes critical, actionable, operations information visible to the enterprise. PI helps companies improve efficiency and reduce costs, but most importantly, also provide the means to initiate quality programs.



Yabulu Refinery Ore Solar Drying Area.

## Quality is the key to success

To achieve the goals for quality control, QNI set up an ISO 9001 Quality Assurance system and in December, 2003 instituted Six Sigma, a rigorous company-wide quality control program. ISO 9001 allowed QNI to:

- Improve product and service quality
- Meet customer expectations
- Standardize overall operations approach
- Improve work processes, efficiencies, and morale
- Reduce waste

While ISO 9001 documents and structures manufacturing process consistency, Six Sigma focuses specifically on eliminating product defects. Six Sigma requires that manufacturers view business and products from the customer perspective. To achieve Six Sigma quality, a process must yield no more than 3.4 defects per million opportunities, where an "opportunity" is defined as a chance for nonconformance, or failure to meet required specifications. Based on statistics, Six Sigma's systematic methodology requires training of all personnel in the quality approaches necessary to define, measure, analyze, improve, and control manufacturing processes.

The Yabulu refinery comprises six business units, each with its own separate control room and controls. Operators spent significant time each shift transcribing numbers from DCS screens into hard-copy log books, then manually entering them into Excel for metallurgical accounting.

Operators need to know everything from shutdown time periods and pump run hours since last inspection, to the number of times a valve opened during a day and process conditions relating to specific batches produced.

Solving a problem typically involved hours or days of searching through hard-copy log books, Excel spreadsheets, or even strip charts, followed by more time to process the data to arrive at an answer.

To justify the cost of installing the PI System, the value of this information had to be quantified. Assigning a dollar value to known production losses was relatively easy — but determining the quantity of the loss without a PIMS in place was nearly impossible.

The Yabulu refinery used a “Balanced Scorecard” (BSC) to measure itself against the company’s strategic goals. Each production area maintained its own KPIs to display performance or improvements against set targets. In the past, this information was nearly impossible to get on a timely basis. But with real-time and historical data stored in the PI System, instant reporting on virtually any metric was available on every desktop.

## Putting the system in place

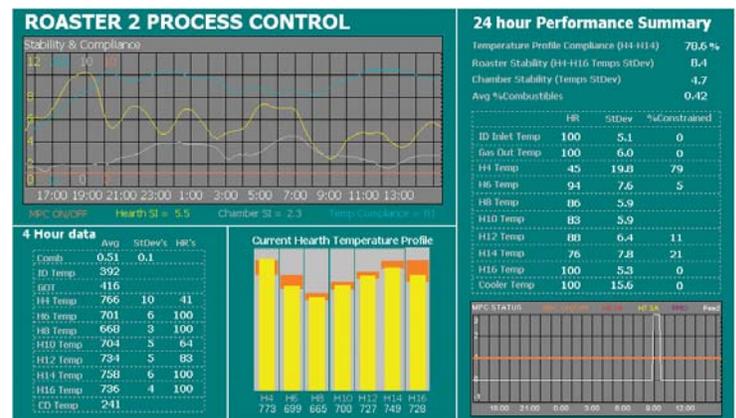
Once justified, Phase 1 included the purchase, installation, and commissioning of all hardware and software required for connection to the System 6 DCSs and the QA Laboratory Information Management (LIM) system. Phase 2 consisted of the configuration of all tags, development of applications for manual data entry, and configuration of real-time displays and reports. The displays were designed and built in-house by Area production people who also provided user training to operators within their Area.

Phase 3 entailed roll-out to the rest of the refinery. PI System installations were expanded to collect more data from more systems. OSIsoft’s Sigmafine™ data reconciliation software was installed for use by Metallurgical Accounts to perform metal balances around the plant and highlight flowmeters that require maintenance. Sigmafine, which has a respected, well-tested presence in the oil and gas and other industries, can read data directly from a PIMS or via an Excel spreadsheet and provide yield accounting services based on trustworthy, reconciled data. These services help track product losses due to bad sensors or leaks, and allow for accurate reporting of inventories to ERP systems.

Phase 4 of the project is still in progress, but involves: interfacing OSIsoft’s RLINK™ to SAP’s PM (Preventive Maintenance) module for the automatic creation of maintenance notifications; automatic downtime recording for a clearer picture of actual downtime causes; more accurate production measures; and upgrading of the IT infrastructure to make the system more fault tolerant.



367 Area Balanced Scorecard showing if monthly KPIs have been achieved. Many of these measures are generated from the PI System.



ProcessBook display showing roaster stability. This display is used by area operations and technical personnel to monitor the stability of individual roasters. Several of the indicators on this display are calculated using PI-ACE and the Module Database.

## Benefits abound at process and management levels

Implementation of the enterprise-level PI System has delivered real, measurable benefits from the plant floor to the front office. Following are specific improvements in various areas of the plant.

**Area 330 (Roasters)** — Combustion temperatures in the roasters reach 1390 -1410° C. Over several years, these temperatures cause the refractory lining to crumble and fall away, damaging the brick work inside the chamber. With PI tracking multiple temperature points within the chamber, OSIsoft's Advanced Computing Engine™ (ACE™) is used to determine how efficiently a roaster is performing, and if it should be taken off-line for maintenance. It also calculates a stability score for each roaster; under-performers, when identified, can be fine-tuned for optimal ore reduction. ACE provides operators with a screen showing the percentage of time that all temperatures were within ±10° C of setpoint over the last six hours.

**Area 340 (Leaching and CCD)** — Here, reduced ore from Area 330 is leached to extract nickel and cobalt into an ammonia solution. Leaching takes place in four parallel trains of four agitated leach reactors. The waste solids are separated from the liquor in an eight thickener CCD circuit. PI permits online tracking of solids inventory through Area 340. This allows operations to closely control the inventory of material within the system, reducing chances to bog down or overload. With PI, downtime is minimized at this stage to avoid significant losses of nickel and cobalt.

**Area 367 (Cobalt Refining)** — The refinery processes an impure Cobalt Sulphide intermediate to high-value Chemgrade Cobalt (CoOOH solid) used in the production of cobalt chemicals and mobile phone batteries. The process is difficult to control, given the number of unit operations and the high quality required in the final product. The densities of each process solution vary with temperature and chemical composition, making flow measurements difficult to calibrate. The PI System confirms flowmeter accuracy by applying real-time mass balances to unit operations in the process. In addition, the ability to perform calculations from DCS data archived in the PI System, as well as laboratory assays, has improved production planning and real-time inventory control in the plant. The PI user interface is simple to use, providing a format familiar to both operators and production support staff. Real-time monitoring of plant operating variables, along with the ability to conduct regular multiple linear regression analyses on plant data have provided a much-improved understanding of a complex process.

**Area 380 (Final Nickel Production)** — In this area, a slurry of basic nickel carbonate is processed to produce Ni metal compacts, nickel oxide granules, and nickel oxide powder. This area uses stand-alone controllers not connected to a DCS or SCADA system. Previously, all trending for process variables was done by chart recorder with operating data recorded in a manual log. Under the PIMS implementation, controller output was connected to the PIMS for data retrieval only. Plant data is now trended in ProcessBook™ (OSIsoft's visualization, trending and analysis tool) with important control parameters for the rotary calciner monitored in real time to reduce operating variability. The ability to collect and monitor both laboratory and plant data permits determination and monitoring of KPIs on a shift basis. Supervisors and process engineers review KPIs regularly to monitor shift performance and identify reasons for any variation in plant performance.

## Major business improvements

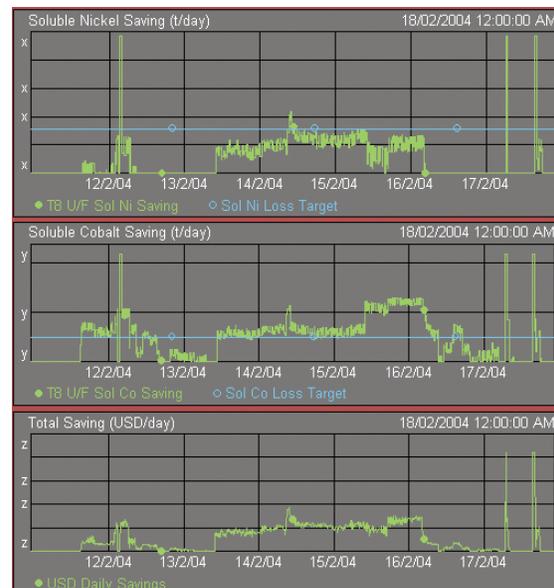
QNI uses OSIsoft's SQC real-time alarm package to monitor quality. Users can continually monitor and evaluate SQC patterns using trends or alarms. Allowable pattern types include outside 1, 2, 3 sigma; and one side of center line, trend, or stratification. Product quality is measured online and through lab analysis. Quality measurement results appear within a few minutes — time enough to ensure that cobalt product quality remains high. Alarm priorities and auto-acknowledge are based on whether the alarm is used only for reporting or for real-time control. The PI System, especially the SQC charts and alarms, provide all the tools to satisfy QNI's ISO 9001:2000 certification.

Cobalt products are typically produced in five-ton batches. Operators record when batches commence and are completed. PI monitors the process; if a customer finds a problem with a product, it's relatively easy to locate the source of the problem. For example, a customer required cobalt in a ten-micron particle size, but some of the cobalt produced had unacceptable particle sizes of 20 microns. PI data and applications were employed to examine variables that had changed before and during the problem batches. It was determined that agitator speed was the cause of the problem. Without PI, days of manual calculation and experimentation would have been necessary to discover the reason. With real-time data, the problem was fixed in under a day, preventing further off-spec batches.

Shift logs, which record process changes during a work shift, had been created manually, making it difficult to retrieve data for inspection. Now PI provides an electronic logbook, accessible from any PC. Comments from the control room operator (CRO) and crew leader are stored in PI and can be easily retrieved for any shift. The logs include KPIs for crew leaders and CROs. Hard copies of plant logs have been eliminated.

Accurate overall equipment effectiveness (OEE) is a measure of how well the plant is running. OEE measurements benefit from a delay accounting module that was built using the PI System that stores instrument data and equipment hierarchies. For example, when a motor stops, a state-of-the-motor tag is recorded in the database. The delay accounting module then flags operators that a section of the plant has shut down. In many cases, it's difficult to determine the impact of stopped pump or slowed conveyor on downtime. ACE, SQC, and alarm calculate "triggers" that affect downtime. PI maintains a long history that enables identification of plant behavior patterns that lead to stoppages, simplifying process adjustment and problem resolution while minimizing delays. Additionally, OSIsoft's RLINK™ interface to SAP's PM module allows maintenance notifications to be automatically generated in SAP, based on predefined events.

QNI used to perform nickel mass balancing as a black box. The monthly reconciliation only showed how much ore went in, how much nickel came out, and the amount of waste or "tailings." Now, Sigmafine validates production information, verifies data quality, and monitors and reports on losses. Sigmafine determines exactly where losses occur in the process, and calculates the month's reconciled recovery. It is also being used to calculate the water balance for the plant, and to track where unmeasured water is going.





*ProcessBook display showing Calciner KPIs. The red line shows the daily target nickel throughput, and the green line is actual nickel throughput for the day. This display is used by Area staff to quickly see if there is a problem with the Calciner. The two pie charts, downloaded from the OSIsoft DevNet site, show the percent of the time in the past 3 days the Calciner was running, and which filter was in use for the majority of the time.*