Plant quality control
The quality control challenge

Cement plants are facing increasingly tough requirements for sample analysis quality and complexity, and for sample throughput. This is partly a result of environmental regulations placing stricter controls on cement production, both in terms of pollution and energy consumption. In addition, the current economic climate demands 24/7/365 cement plant operation, with as little manpower as possible.

Many new cement plants are located in areas where it is difficult to recruit skilled engineers, and people who are available often spend less time in the same job. Remote operation, support from distant locations, and online assistance are all vital for the smooth operation of quality control systems in modern cement plants.

The trend in cement plant quality control systems is to meet the following requirements:

- Operate a production laboratory with as few operators and engineering resources as possible
- Improve the speed and accuracy of sample results
- Meet the stricter controls required for specialised cement
- Support 24/7/365 operation
- Achieve zero health and safety incidents

Supporting product quality control at all stages

The QCX® system from FLSmidth is designed to control cement quality in cement plants and it fully meets industry standards for reliability and robustness in an industrial environment. Automated sampling, sample preparation and analysis provide fast, reliable and consistent information for quality and process control.

Solving quality control challenges

Shortage of skilled lab-operators – Laboratory managers need to be less reliant on human resources, and still maintain high quality. The QCX system:

- Automates sample taking, preparation and analysis – reducing the need for manual labour
- Ensures consistent high-quality sample taking, preparation and analysis, by programming desired recipes
- Is part of FLSmidth's global support organisation for fast and easy remote troubleshooting

Inconsistency in sampling – Sampling inconsistency and inaccurate analysis results contribute to laboratory errors, creating process fluctuations and disrupting productivity, equipment lifetime and especially product quality. To dramatically improve sampling quality, the QCX system:

- Automates sampling, ensuring accuracy and reliability
- Automates sample transport, ensuring correct sample place and timestamp on sample
- Offers full traceability, from sampling to analysis

Tighter controls for special cement or alternative fuel – Competitive production methods using alternative fuels and additives put very tight requirements on quality control. Likewise special cements require stricter controls and special analysis. To meet strict controls, the QCX system:

- Delivers advanced sample preparation, such as automated sample fusion
- Ensures that frequent and consistent results are fully available

Strict documentation requirements – Stricter QC and audit trail requirements are part of the daily operation of cement plants. The QCX system supports:

- Unmanned documented handling of material from process to analysis
- Avoiding introducing human bias

Cost-effective production – Fast and accurate results – Cement production requires fast and correct results to improve quality and reduce operational costs. For cost-effectiveness, the QCX system:

- Delivers fast and accurate automated sample taking, preparation, analysis and control

Continuous plant operation – For 24/7 plant operation, the process laboratory must operate constantly with only very few, short stops. This means that efficient maintenance and service of all equipment is crucial. To support 24/7 plant operation, the QCX system:

- Monitors key components' KPIs, enabling verification of run hours and end of lifetime for wear parts – facilitating spare-part sourcing and reducing downtime for maintenance

Prioritising safety – Cement plants are striving to improve safety. Supporting an improved working environment, the QCX system:

- Eliminates hazardous manual operation and operator injuries by automating sampling and sample preparation
The QCX system

FLSmith’s comprehensive equipment portfolio, designed specifically for cement production laboratories, ranges from manual machines and automated units to fully automated, high-capacity laboratories.

By design, most of FLSmidth’s laboratory equipment is semi-automated and can also be operated manually, as stand-alone equipment. This means you have the advantage of implementing stepwise automation and of ensuring operation, even when part of the automated laboratory is being serviced.

A solution for every need

The QCX system ensures that your process laboratory delivers safe, efficient and accurate analysis – quickly and with as few operators as possible. The advanced, user-friendly system can be tailored according to your specific cement production needs, including special cement and fuels, and supports 24/7/365 operation.

More than 40 years of development across multiple hardware platforms and a comprehensive base of installed systems has made the QCX system the frontrunner in the cement industry. Automated laboratory solutions from FLSmidth are setting new industrial standards in terms of ease of use, flexibility, reliability and scalability.

For exceptional quality and process control at all stages of cement production, the FLSmidth QCX system:

- Automates sampling, sampling preparation and analysis
- Provides safe, fast and reliable information
- Integrates all cement quality-control activities in a single system
- Incorporates in-depth understanding of the production process
- Allows for any degree of cement production in the software design automation through its modular design.

QCX system overview

This brochure provides you with an overview of the 4 essential elements that make up the FLSmidth QCX quality control system.

FLSmith offers a fully integrated quality control system for your plant – from state-of-the-art software and equipment to expert engineering, project management and support.

Process knowledge brings full traceability, compliance with rules and requirements Quality assurance adapted to local requirements.

Training of all staff levels, after-sales support, remote support

Capable staff will ensure success after we leave site, and remote support will guarantee it.

Operate and maintain the system with few people due to ease of use and user friendliness

Improved and consistent sample quality results in improved production quality.

Ensuring correct, safe sample taking and preparation, all equipment is compliant with CE (H&S) LTBI down, sample throughput up, complex preparation made possible.
The QCX software includes the following components:
- QCX/Manager – the backbone for all QCX systems
- QCX/Reporting – the trend and reporting software
- QCX/AutoSampling – the sampling and sample transport software
- QCX/RoboLab – the laboratory automation software.

**Unique equipment integration**

The QCX system is designed and engineered to get full transparency from the software in the laboratory and down to the devices in the samplers and sample preparation equipment. This transparency is possible because the equipment and the software development go hand in hand in the QCX system. The seamless integration of sub-components and the control system saves time during commissioning and later during maintenance.

**Faceplates**

Easy-to-understand and pre-configured QCX faceplates allow operators and maintenance personnel to monitor equipment status. These faceplates give an overview, save time, and eliminate the need for operators or engineers to dig into PLC programs. All relevant information is readily available in all formats.

**Performance metrics**

The QCX equipment is delivered with integrated performance metrics, providing valuable usage and performance information for managers, operators, and maintenance staff. Key Performance Indicators, such as Availability and No of produced samples, provide a quick overview of equipment performance, while more detailed information, such as Motor runtime and No of cylinder operations, is targeted for maintenance staff.

**Remote assistance**

Automated laboratories can rely on remote assistance either from FLSmidth or from the user’s own service organisation. This saves manpower and minimises downtime.

**CE compliance**

Health and safety considerations are an integrated part of the design and production processes of the QCX system, and all the equipment and systems comply with CE marking requirements. These requirements are based on internationally recognised standards, such as ISO and IEC, meaning that you automatically fulfil the requirements of many relevant health- and safety-related standards when choosing the QCX system. Additional certification – or compliance with additional standards – is in many cases available on request.
The components of quality control

QCX/Manager

QCX/Manager is the kernel software module of a QCX system. It includes sample administration, sample tracking, sample preparation recipes, and data import/export facilities.

Combining the functionalities of the Laboratory Information System (LIS) and the Laboratory Automation System (LAS) in a unique setup, the QCX/Manager software is prepared for any degree of sample automation. In addition, the user configurators save you time and ensure consistency when designing and updating sample preparation recipes, ultimately reducing errors.

Benefits of the QCX/Manager software

• Fully documented transparency from sample processing to analysis
• Complete overview of sample status, sample analysis and statistics
• Full traceability of sample taken time and sampling point
• Efficient creation and updating of sample preparation recipes

QCX/Reporting

QCX/Reporting is your documentation tool. You can generate daily, weekly and monthly reports based on your specific plant requirements and chemically calculated values, such as SiO2, ALM and LSF.

The QCX/Reporting software comes with a number of predefined reports based on the most common requirements from cement plants. Furthermore, if your plant has an FLSmidth process control system, then process parameters, such as tons produced or fuel consumed, can be trended together with quality parameters to optimise operation.

Benefits of QCX/Reporting

• Fully documented transparency from sample processing to analysis
• Complete overview of sample status, sample analysis and statistics
• Full traceability of sample taken time and sampling point
• Efficient creation and updating of sample preparation recipes
• Direct access to trends to investigate quality parameters, for example, a combined trend view for Blaine results in the last 3 months for all cement samples.
QCX/RoboLab
The market leader of cement plant automation, the flexible QCX/RoboLab solution includes a comprehensive software package for automatic sample preparation, sample analysis, and automated QA and QC procedures. The software ensures documented QA by, for example, enabling duplicate or triplicate sample preparation and analysis, or introducing blank samples at predefined times.

Managing the route that your samples take through dedicated sample preparation equipment and controlling analysers in the automated system, the QCX/RoboLab solution provides you with practically unmanned sample preparation and contains all the relevant equipment drivers, diagnostics tools and informative uniform equipment faceplates.

QCX/RoboLab automated tasks include:
- Sample coordination and reception from the QCX/AutoSampling system
- Sample dosing into sub-samples
- Particle characterisation
- Sample preparation – pressed pellets or fused beads
- Combustion analysis
- XRF and XRD analysis

Benefits of the QCX/RoboLab
- Minimal cross-sample contamination through integrated cleaning
- Dedicated preparation equipment for special samples
- Automated QA/QC procedures
- Simple and easy-to-use UI
- Intuitive faceplates
- Uniform equipment KPIs, resulting in efficient preventive maintenance
- Seamless integration to the QCX/AutoSampling system and the FLSmidth plant control system.

QCX/AutoSampling
The QCX/AutoSampling solution provides accurate sampling, including fast, automated sample transport to the laboratory and documentation of sample origin and timestamp. The way samples are taken and the sampling frequency, eliminate sampling bias when calculating plant quality.

Benefits of QCX/AutoSampling
- Correct sampling, including the right location and timestamp
- Consistent sampling quality, eliminating sampling bias
- Fast turnaround time – the sample reaches the laboratory within minutes
- User-friendly system information available in the laboratory
- Improved maintenance data reduces the number of potential equipment stops and maintenance
- Seamless integration to other QCX products.

“With the QCX/AutoSampling solution, you can avoid incorrect sampling, which is responsible for up to 85% of all analysis errors”
Since 1989, FLSmidth has supplied reliable, fully automated solutions providing fused beads for X-ray analysis with precisely weighed sample and fluxes. X-ray analysis plays an important role in the quality and process control of cement production. The analysis rapidly and accurately measures the chemical composition of raw materials and ores. But your analysis is only going to be as good as your sample preparation, which is crucial. Truly accurate analysis relies on good sample preparation.

The FLSmidth DCF8X0 units automatically prepare fused beads for analysis, including the dosing, weighing, and mixing of flux and sample, cleaning of the crucibles as well as fusion. Developing a robust and reliable fusion technology requires ultrafine mechanics for automatic dosing with 1/10^10 of a milligram weighing precision, as well as handling objects with temperatures higher than 1000 °C. The fact that, for more than 15 years, many cement plants have had automated fusion in a QCXRoboLab system as the sole preparation technique for XRF analysis, is evidence of the robustness and reliability of the FLSmidth fusion technology.

With the DCF820, you can make up to 10 beads per hour, and for increased capacity, the DCF830, which has four muffle furnaces, can do double this amount.

Benefits of DCF units
- Cost-effective automated preparation of fused beads
- Accurate XRF analysis
- Optimal reproducibility
- Increased laboratory capacity
- Faster access to data
- Reduction of manual tasks
- Easy maintenance of all sections of the equipment.

The DCF820 machine has 3 functionally separated sections:
- Top section – integrated muffle furnace
- Middle section – a high-precision flux and sample dosing, weighing station operating at 0.0001 g precision levels
- Lower section – a cleaning section for ‘dirty’ crucibles returned from the fusion section.

Automatic powder sample preparation

FLSmidth’s award-winning Centaurus sample preparation machine consists of a fine grinding mill and a pelleting press, integrated with dosing and cleaning components in a space-saving and ergonomically designed housing. The total footprint is only 1m².

The fully automatic Centaurus produces pressed powder test tablets from granular materials, such as raw meal, clinker, cement, ore, slag and mine exploration samples for XRF and XRD analysis.

Features include:
- Very low sample to sample contamination
- Pressing only function
- Grinding/pressing only function
- Air cooled mill
- Pressed pellet consistency check
- Input sample magazine.

Automatic powder sample preparation for X-ray analysis has been undertaken by QCX systems since 1978. Since then, FLSmidth has delivered close to 200 automation projects with automated powder preparation.

The Centaurus gives on quality, capacity, ease of use and reliability in sample preparation.

Features include:
- Very low sample to sample contamination
- Pressing only function
- Grinding/pressing only function
- Air cooled mill
- Pressed pellet consistency check
- Input sample magazine.

Next generation X-ray sample preparation

With a range of unique features, FLSmidth has taken X-ray sample preparation technology one step further with the Centaurus sample preparation machine.

Automated powder sample preparation

FLSmidth’s award-winning Centaurus sample preparation machine consists of a fine grinding mill and a pelleting press, integrated with dosing and cleaning components in a space-saving and ergonomically designed housing. The total footprint is only 1m².

The fully automatic Centaurus produces pressed powder test tablets from granular materials, such as raw meal, clinker, cement, ore, slag and mine exploration samples for XRF and XRD analysis.
Consistent and fast blaine analysis
The fully automated AB800 unit performs blaine analysis, making specific surface measurement, quick and consistent.

The analyser assesses the permeability of the material bed, the porosity of which is defined by the measured mass and the known volume. This procedure complies with the EN196.6 standard.

Features of the AB800 analyser:
• Can be calibrated for 16 different materials
• Commissioning includes calibration and set up of 5 different materials
• Can be equipped with an exchangeable sample rack, allowing it to process 30 samples per batch.

The AB800 unit performs the following processes:
• Gravimetric dosing
• Weighing
• Compression of material
• Permeability measurement
• Calculation of Blaine values based on calibration and material type.

Laser particle sizing
Laser particle sizing provides detailed information about the entire particle size distribution of products sampled throughout a cement plant. In particular, for samples taken in the cement grinding circuits, the data collected provides important information for optimising grinding efficiency, with power consumption in focus.

Sample magazines
The smart and flexible sample magazine concept, the Turn Table Rack (TTR), offers sample input and output and sample storage in one compact solution, with a small footprint.

The TTR delivers every type of magazine/buffering functionality your automated cement plant laboratory needs. For example, you can configure it with storage space for many sample cups or rings and a few composite containers, or, alternatively, with a few sample cups and several composite containers – or any configuration in between.

The TTR supports:
• Entry of samples to the QCX/RoboLab system
• Delivery of portions of automatically sampled material for manual preparation and analysis tasks outside the automated system
• Buffering of sample portions in waiting positions
• Back-up position for high-priority samples for possible repetition of a given preparation/analysis task
• Storage of empty sample cups or steel rings
• Composting samples collected over a shift.
On cost, on time, on spec

FLSmidth ensures every aspect of your project stays on track. In a challenging project, outstanding project execution capabilities can make all the difference. FLSmidth’s comprehensive capabilities for successful project execution include having the right people, skills, experience, processes, technology and support to ensure that projects are delivered to consistently high standards.

Expert management

**Project management**

A dedicated project manager is assigned to coordinate all internal and external activities through the entire lifecycle of the project. This person is your main contact. At an early stage in the project, the project manager provides a detailed project plan, indicating the individual phases and all key deadlines, milestones and project meetings.

**Site management**

In more complex projects, a site manager is appointed to assist the project manager. This role prioritises daily work to optimise overall progress, organises on-site tasks and holds project meetings to coordinate joint activities.

Highly experienced project execution teams reduce risk, control scope and meet your schedule, budget and project parameters, so you can trust that your project will be delivered on spec and on time. The worldwide network of offices also ensures local support.

Typically, project execution is divided into four phases:

- **System engineering**
- **Shipment and installation**
- **Commissioning and optimisation**
- **After-sales service**

**System engineering** includes developing project-specific drawings and diagrams, configuring the QCX software, robot and PLC programming, and producing equipment. The engineering is verified by an equipment acceptance test.

This phase also includes programming or configuration to integrate with your existing system.

Installation is often undertaken by customers themselves, as they have prior experience dealing with local contractors. FLSmidth provides detailed pre-installation services to train and support installation personnel.

**Commissioning and optimisation** involves on-site services provided by FLSmidth to bring the delivered equipment and software into correct operation. Installation and commissioning are typically joint activities, with the aim of achieving a smooth and rapid start-up. It is essential that dedicated end-user personnel are appointed to follow these activities as they will support the system in the future. Depending on the magnitude of the project, commissioning can last a few days to several months.

**Supply chain management**

A team of dedicated logistics coordinators manage all logistics processes in the supply chain, once an order has been placed. These processes involve purchasing, expediting, packing/warehouse and shipping to our customers worldwide.

With broad experience in all aspects of logistics and supply chain, we ensure the necessary handling of all order types on complex logistics processes. In close co-operation with Project Management, we arrange for detailed milestone planning throughout the project, securing that we stay on track and are focused on timely delivery and customer satisfaction.

---

<table>
<thead>
<tr>
<th>Week 0</th>
<th>Week 3</th>
<th>Week 8</th>
<th>Week 13</th>
<th>Week 18</th>
<th>Week 23</th>
<th>Week 28</th>
<th>Week 33</th>
<th>Week 38</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Project kick off and milestone definitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 Execution work QCX/Manager</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3 Execution work QCX/AutoSampling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4 Execution work QCX/RoboLab</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.1 Equipment arrangement drawings and layout</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.2 Technical clarifications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.3 QCX/Robolab equipment purchase</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.4 Electrical and mechanical documentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.5 Project specific PLC programming incl. test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.6 QCX server and client installations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.7 QCX software documentation and system backup</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.8 Equipment manufacturing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.9 Robot assembly and test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.10 Final review of documentation and drawings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.11 Inspection in presence of client or third party</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.12 Equipment ready for shipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 QCX Installation Plan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5.1 Onsite formalities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5.2 Equipment installation supervision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6 Commissioning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6.1 QCX/Manager</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6.2 QCX/AutoSampling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6.3 QCX/RoboLab</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Customer support and services

FLSmidth offers a wide range of services to help you secure your investment in the QCX system, providing maximum satisfaction and productivity by ensuring performance, utilisation and productivity.

Together with FLSmidth, you can define the best possible combination of training and service to fulfil your needs.

Lifetime satisfaction
New technology allows for many new opportunities but it also requires new skills and support for it to succeed. To support our customers in achieving the highest return on investment, FLSmidth has a number of services. Our training programme ensures skills development for your staff and FLSmidth will take over if the tasks become too complex. A service agreement that includes regular on-site maintenance and optimisation is a popular and ideal way to get a smooth and secure introduction to new technology.

When plant engineers become familiar with the technology, the services will naturally change. Spare parts, upgrades and remote support and optimisation come into focus. In-depth training and training new staff will make sure that on-going skills development includes the newest features and opportunities.

No high-end technology lives forever. To optimise the return on assets, FLSmidth retrofits and migrates solutions to ensure equipment performs for as long as possible and an FLSmidth assessment will help you find the best possible transition to use new innovation.

PlantLine service agreement
The PlantLine™ service agreement consists of modules making it possible to tailor agreements to meet your unique requirements. A service agreement is a prudent investment that gives top priority to emergency assistance. You are supported through on-site service visits and remotely through a hot-line and the Internet. The result is reduced system downtime and optimal plant performance.

FLSmidth’s remote services give unique possibilities for services from a distance, saving time and the travelling costs of specialist visits. By allowing access to monitor a software application, it is possible to evaluate problems remotely and even make corrections and optimisations. This is done online while the system engineer or the operator follows every step.

Preventive maintenance visits include maintenance and optimisation of the system, assessment of normal plant maintenance and recommendations for securing high availability and a long lifetime of the system.

Training programmes
One of the secrets of the success of FLSmidth is the course-development process. Best practices are continuously reviewed and training focuses on the latest knowledge and experience, both in a classroom setting and in practical exercises. The courses are designed with proven methods of effective learning in mind, acknowledging the complexity of individuals and different learning styles.

To secure a professional knowledge transfer throughout the product lifecycle, the training objectives are aligned with the European Qualification Framework. Please refer to the FLSmidth Automation Training Catalogue for more details.

Course sequence for laboratory automation training