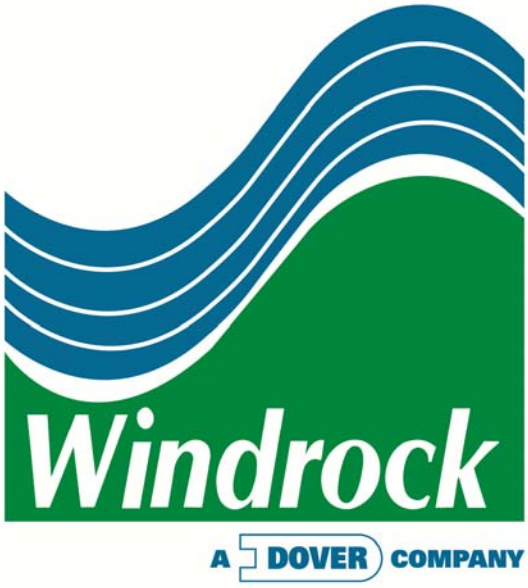

On-Site Customer Training

Analyst Support and Qualification Program

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Program Definition

The **Analyst Support and Qualification Program** (ASQP) provides customer site-specific training and is designed to provide a structured development concept for the purpose of establishing, cultivating and sustaining a core group of trained analysts with skills obtained through hands-on training and classroom environments.

Goals for the participants are to obtain the ability to assess operating inefficiencies, poor mechanical condition, and the probability of problems or failures prior to costly repairs.

The program, as outlined herein, contains the schedule in its entirety. This program can be modified to better fit each customer's asset management needs. The built in Qualification Certification component for compressors, engines and FFT is optional.

Program Benefits

Customers realize proven increases in operating profits through increased efficiencies And a reduction in losses as a direct benefit of investing in their personnel through this structured, extended-term program.

Program Overview

Designed as an alternative to traditional classroom training, the Windrock ASP program will work with *your* personnel, at *your* location, testing and analyzing *your* equipment while teaching them how to read and interpret *your* data.

This is a progressive hands-on program consisting of eight weeks of on-site training with interim support through live webinars and other resources.

Qualification Exam and Certificate Program Overview

Participation in the **Qualification Exam and Certificate Program** also provides supervisors with an effective tool for employee evaluation and review processes as well as career path direction for staff team members.

Upon successful completion of the AQA1 module, participants are able to take Qualification Exams at the conclusion of each of the level 1 and 2 Engine or Compressor modules or the level 1 FFT module. The AQA2 module will need to be taken to be eligible for the level 3 engine and or compressor or the level 2 FFT modules.

Qualification Exam fees are $250.00 per participant per class. In the event that further review and a retest is necessary, a second test will be provided at no additional charge.

Program Modules and Suggested Schedule

Week 1

AQA1 (Win6320 or RTWIN 9260)
Introduction to Reciprocating Machinery Analysis

- Mechanical relationships
- Analyzer hardware familiarization
- Sensor identification and specifications
- Proper setup of the reciprocating machinery for analysis
- Analyzer setup
- Data collection techniques
- Analyzer equipment safety
- Data collection safety

Students are supplied with workbooks and a USB flash drive geometry database

Interim period – Students will continue setting up routes and collecting data with support provided for feedback and Q&A through a webinar between a Windrock analyst and participants

Interim period (four to six weeks) – Students should continue collecting data and practicing new techniques. Support provided for feedback and Q&A through a webinar between a Windrock analyst and participants

Weeks 2 – 3 Class selections are dependent upon the chosen Qualification Track (Engine or Compressor)

Weeks 6 – 7 FFT Qualification Program (Optional)

Week 2

AQC1 (Basic Compressor)

Basic Reciprocating Compressor Analysis

- Definitions
- Physical characteristics
- Data collection safety
- Sensor point selection
- Visual inspection procedures
- Basic compressor theory
- Determining toe pressures, compression ratio, volumetric efficiencies, horsepower
- Pressure vs. crank-angle
- Vibration vs. crank-angle
- Ultrasonic vs. crank-angle
- Performance report
- Panel report
- Field reporting

or

AQE1 (Basic Engine)

Basic Reciprocating Engine Analysis

- Database setup review
- Engine systems visual inspection procedures
- Basic engine theory (Spark ignited and Diesel)
- Sensor point selection
- Data collection
- Pressure vs. crank-angle
- Pressure vs. volume
- Vibration vs. crank-angle
- Ultrasonic vs. crank-angle
- Ignition analysis
- Engine mean peak pressure balancing

Interim period (four to six months)– Students should focus on collecting data and the basic analysis of the collected engine / compressor data. Support provided for feedback on data collected, analysis derived and Q&A through a webinar between a Windrock analyst and participants

Week 3

AQC2 (Intermediate Compressor)

Intermediate Reciprocating Compressor Analysis

- Latest software features review
- Compressor theory
- Channel resonance identification and correction
- Theoretical pressure - volume models
- On-machine data evaluation
- Log P vs. Log V plots
- Leak index
- Rod load
- Rod run out
- Rod wear
- Rod reversals
- Intermediate pattern interpretation

or

AQE2 (Intermediate Engine)

Intermediate Reciprocating Engine Analysis

- Latest software features review
- Intermediate engine theory (SI and CI)
- Formulas used in performance evaluations
- On machine data evaluation
- Application of spike filtering
- Calculating phase relationships
- BSFC measurement
- Creating fuel curves
- Mechanical efficiency determination
- Intermediate engine diagnostics
- Intermediate pattern interpretation
- Horsepower balancing
- Priority and probability assignment
- Formal report procedures

Interim period (2 – 3 months) – Upon reaching this point the participants should be comfortable with basic and intermediate engine or compressor analysis and reporting. Proficiency as an equipment analyst is acquired through experience. Windrock's training will accelerate the learning but it is crucial during this time that the students be allowed to hone their skills through practice while being mentored by a Senior Windrock Analyst via telephone, email, or webinar support as needed.

Week 4

AQA2 (Win6320 or RTWIN 9260 Advanced Software)

Advanced Software and Data Collection

- Review of routes set up by participants during the interim
- Week's focus centered around reinforcing and advancing correct data collection techniques and software features to include:
    - Database maintenance
    - Complete software review
    - Diagnostic features
    - Sensor identification and specifications
    - Hardware configuration editing
    - Advanced reporting techniques
- Data collected during this session that is not analyzed on site will be analyzed off site with results forwarded to the customer

Week 5

AQC3 (Advanced Compressor)

Advanced Reciprocating Compressor Analysis

- Latest software features review
- Advanced compressor theory
- Gas properties
- Formulas used in performance evaluations
- Pulsation
- Crank-angle bearing pattern diagnosis
- Operating clearance verification and diagnostics
- Advanced leakage diagnostics
- Detailed performance data collection and horsepower curve verification
- Advanced pattern interpretation
- Detailed performance testing
- Compressor economics

or

AQE3 (Advanced Engine)

Advanced Reciprocating Engine Analysis

- Latest Software features review
- Advanced engine theory (SI and CI)
- Formulas used in performance evaluations
- Advanced engine diagnostics
- Engine Log P vs. Log V
- Crank-angle main bearing and rod bearing analysis
- Advanced engine pattern analysis
- 1^{st} and 2^{nd} derivatives
- Power cylinder compression modeling
- Advanced combustion characteristics
- Data export and spreadsheet report creation

Interim period (four to six weeks)– Students should continue collecting data and practicing new techniques. Support provided for feedback and Q&A through a webinar between a Windrock analyst and participants

Week 6

AQV1

Basic Reciprocating Machinery Spectrum /FFT Vibration Analysis

Prerequisite: Successful completion of AQA1 or currently using the analyzer and have successfully completed the appropriate Analyzer Startup Assistance Training. Requires instructor interview if AQA1 was not taken.

- Basic Vibration
    - Time Waveform, FFT
    - Period, Phase, Frequency (CPM, Hz, Orders)
    - Amplitude (peak, peak-peak, rms)
    - Unit of Measure (displacement, velocity, acceleration)
    - Vibratory force
- Data Acquisition
    - Selecting a unit of measure
    - Transducer selection
    - Transducer mounting
    - Data collection principles
    - Safety
- Data Processing
    - Acquisition time
    - Resolution
    - Fmax
    - Basic Averaging
    - Window selection
- Route and point setup
    - Auto-generate, editing, reordering points
    - Route planning
    - Machine knowledge requirement
    - Basic Alarm Settings
- Fault Analysis
    - Basic Spectrum (FFT) analysis
    - Basic Time Waveform analysis
    - Basic Fault signatures (unbalance, misalignment, blade pass, Pulsation)
- Plot and report creation

Interim period (four to six weeks)– Windrock analysts are available for Webinar support in order to provide timely instruction for the participants relating to both their data collection validity and to review the student's analysis and report findings using their collected data.

Week 7

AQV2

Advanced Reciprocating Machinery Spectrum /FFT Vibration Analysis

- Advanced Vibration
    - Time Waveform, FFT
    - Period, Phase, Frequency (CPM, Hz, Orders)
    - Amplitude (peak, peak-peak, rms)
    - Unit of Measure (displacement, velocity, acceleration)
    - Vibratory force
    - Sidebands
- Data Processing
    - Synchronous Time Averaging
- Route and Point setup
    - Alarm setting evaluation
    - Band setup
- Fault Analysis
    - Advanced Spectrum (FFT) analysis
    - Advanced Time Waveform analysis
    - Calculating fault frequencies
    - Advanced Fault signatures (unbalance, misalignment, vane/blade pass, Pulsation, bar pass, electrical, rolling element bearings, sleeve bearings, gears, belts)
- Condition Evaluation
    - Chart application
    - Using Historical vibration levels
- Machine Testing
    - Periodic Monitoring
    - Acceptance Testing
    - Impact Testing
    - Phase Measurement
    - Frame Movement
    - Cylinder Stretch
    - Pulsation
    - Transient Data collection and Analysis

Interim period – Windrock analysts are available for Webinar support in order to provide timely instruction for the participants relating to both their data collection validity and to review the student's analysis and report findings using their collected data.

Week 8

Final Recap and Evaluation

- This final week is an open discussion with a comprehensive review of all prior training
- All final qualification exams remaining should be administered during this time onsite
- To ensure that benefits are being realized from this program, customer management and Windrock analysts will conduct a meeting immediately following the conclusion of the training to ensure that systems are in place for evaluation of the results from this training through the effective tracking of:
    - Reports being prepared by the analysts
    - Reduction in operating costs
    - Increase in machine, personnel, and facility performance

Windrock's staff of instructors, (combined total of more than 125 years of testing and training experience), are dedicated to the education of equipment analysts. Your personnel will receive a level of individual instruction and attention unsurpassed in the industry.

Truly, the best value for your training dollar.