CMVA Certification Program Category 1 – Data Collection Performance Objectives

Basis

These performance objectives define what an individual certified at Ultrasound Category I should be able to do, on the job. They are based directly on the ISO standard 18436-8 and 29821 and were prepared by members of CMVA's Training and Certification Committee.

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The major (but not exclusive) focus of each category is as shown in the title. Vocabulary is part of the required knowledge at each category.

The noted percentages are derived roughly from the ISO standard, which indicates the number of hours during a 30-hour course to spend on each topic.

The experience prerequisite for a category I exam is 6 cumulative total months.

Examination and Certification

Anyone who has mastered the indicated performance should be able to pass the associated test.

In general, there will be approximately the same percentage of exam questions on each topic as the study time suggested in the ISO standard. Each exam consists of 60 multiple choice or true/false questions, and the exam is different each time it is given.

Exam questions are straightforward. Don't look for hidden meanings. If you think a question is tricky or badly worded or unfair, note that fact on the test; it may be taken into consideration in the marking and the question will certainly be reviewed before the test is given again.

Table 2 — Minimum cumulative experience requirements

Durations in months

Category I	Category II	Category III
6	12	36

Minimum duration of cumulative training

Durations in hours

Category I	Category II	Category III
32	64	96

Number of Hours Allowed To Write the Exam (minimum pass mark is 70%)

Category	1	2	3
# of questions	60	60	60
# of hours allowed	2	2	2

1. Principles of Ultrasound 15% - about 9 questions per exam

Definitions, Relationships

- Basics of sound
- Sound wave motion
- The velocity of sound
- Frequency of sound
- Define cycles per minute (CPM), Hertz (Hz)
- Acoustic impedance and its influence on propagation and attenuation
- Inverse distance law
- How friction turbulence and impacting produce ultrasound
- Understanding the properties of the decibel (dB)

Relate real-world events to conventional patterns

- Observe a leak, friction and electrical sounds
- Draw the ultrasound waveform
- Draw the ultrasound spectrum
- Illustrate with reference to the time waveform the use of the true peak (zero to peak)
- Illustrate the use of the root mean square (RMS), Max RMS, US Peak and crest factor
- Recognize that some instruments take an RMS reading and multiply it by the square root of 2 to get an estimate of peak reading (often called

pseudo-peak), and identify the limitations of this approach.

Calculations

- Convert from Hertz (Hz) to cycles per minute (CPM), and from CPM to Hz, and be able to relate either of them to revolutions per minute (RPM) if appropriate.
- Calculate acoustic impedance
- Convert from dB uV to uV.
- For single frequency components, calculate the root mean square (RMS) from the peak reading, and the peak reading from the RMS reading.
- Calculate period from frequency and frequency from period and read them from graphs.

2. Generic Equipment Knowledge 8% - about 4 questions per exam

Safety

- Pay due care and attention to the safety of yourself and others. Your safety is your responsibility.

Instrument Operation and Function

- Take good care of your instrument, paying attention to transducers, cables, batteries, and recommendations in its User's Manual.
- Instrument operation and function
- Airborne sensors
- Structure-borne sensors
- Heterodyne principle and application
- Sensitivity validation
- Recognize and trouble-shoot ultrasound sensors or cable problems by properly using the instrument's built-in check features
- Check the calibration of your instrument with its sensors periodically, as recommended in its manual, and whenever you have reason to suspect the quality of data it is generating (such as if the structure borne sensor was dropped). If it is not within specs, have it calibrated before collecting more data.

3. Data Acquisition in Ultrasound 10% - about 6 questions per exam

Presence in the Plant (Safety)

- Make sure the appropriate people know you are collecting data at this time, as defined by plant policy (e.g. work permit, hot work permit, conversation, etc.)
- Pay attention to surroundings, especially rotating equipment, loose cables, loose clothing, jewelry, shoulder straps must have tear-away connectors, etc…

Personal Observations

- In addition to collecting ultrasound data with your instrument, make systematic observations of the machine and its environment using eyes, ears, nose and touch. Record anything that might be affecting the machine, such as speed, load, temperature, fluid, production anomalies, sources of competing ultrasound, position of louvers, etc. (if and only if these items change from time to time).
- Observe and record potential problems. If a potentially serious problem arises (e.g. unusual loud noise, major oil leak), interrupt data collection and report it.

Principles of Data Acquisition

- For reliable data identify an area on the asset where readings can be taken that are accurate and repeatable. Typically, this will be in the load zone, but not always. Therefore, take readings from a variety of positions to determine the highest signal. Then mark that position so that it is always used in subsequent collections.
- Acquire valid repeatable data at the correct test point on the correct machine, using the correct transducer and the correct frequency range, for the appropriate length of time.
- Use a measurement point that provides best possible transmission of the ultrasound signal
  - e.g. solid steel between housing and bearing – and use the identical test point each time. Mark the points.
- Place the contact sensor on the test point carefully, without banging it.
- For hand-held readings taken without a magnetic mount, hold the probe firmly enough to get the reading to steady out, and keep holding it the same way until data collection on that test point is complete. Use the same technique for every reading, and make sure other data collectors at your site also use the same technique. If different people can take data two or three times in a row, and get the same result, your technique is good.
- For other mounting types, make sure mounting surface on machine is clean and dry and appropriate.
- Observe reading and compare to previous reading on same test point (if

instrument allows) as data is being collected. If there are serious discrepancies, check further: instrument, cable, sensor in good shape, test point right, technique right, what else is going on that might cause the difference (load and speed of machine)? is the unit running? – i.e. try not to go back to the office and then have to wonder about all these things.

- For variable speed machines, sample speed automatically if the route is set up to do this and the appropriate speed signal (one pulse per revolution) is available, or enter speed manually as a variable or a note from a local display where appropriate.
- Collect data from any permanently mounted transducer (including continuous monitoring systems), based on the capabilities of the instrument you are using.
- Be aware of competing ultrasound and use appropriate shielding techniques to counter them.
- Importance of consistent sensor placement from one data collection event to another.

Sensors

- Describe different types of ultrasound sensors and the parameter(s) they measure
- Be able to identify ultrasound sensors (e.g. and relate them to the type of measurement required
- Identify the physical limitations of different sensors, including frequency response and temperature limitations
- Determine when sensors need power

Sensor Positioning

- Define different sensor mounting techniques and their uses. Consider handheld (probe, stinger), magnet, adhesive, wax, and stud. Name potential problems associated with different mountings.

Competing ultrasound and shielding techniques

- Learning the different shielding procedures to block out competing ultrasound sources.

Measurement of ultrasound

- Calibrating measurements
- Inverse distance law

Capturing time domain and spectrum signals for analysis

- Discuss the differences between a time waveform (TWF) and spectrum (FFT)
- Identify frequency from a spectrum
- Identify overall versus waveform versus spectrum

4 Data Storage and Management 5% - about 3 questions per exam

Developing and using a database

- Take good care of your computer, paying attention to data backup (including off-site), file management, virus checking, proper storage of removable storage, etc.
- When developing your database, create a database that is manageable and efficient for the data collection and data reporting
- Load the appropriate survey from the computer into the instrument.
- Transfer the acquired data into the computer and verify that it is appropriate and recoverable, before erasing it from the instrument.

Managing stored data

- Properly manage the stored data by ensuring that the database has only good data; delete any data that is shown to be erroneous.
- Ensure that alarms are recorded in the database and report any disposition of anomalies.
- For machines that have exceptions, compare current readings to their history, to related readings on similar machines, and to records of process variables that may affect ultrasound, and inform designated person of the results.
- Generate Exception Reports and send to people designated by supervisor, as per schedule. Typically, these reports would be comprised of a list of machines that exceed alert or alarm levels, complete with the test points that exceeded limits and the overall values of the readings in question.

Disposition of anomalies

- Be able to suggest bad data due to hand motion, clipped signal, insufficient settling time, conflicting information, bad mounting, inappropriate scale, machine not running, ultrasound picked up from another machine, or instrument problems (e.g. contact sensor overload or bounce (looseness).
- Evaluate survey data and determine that no bad data was collected.
- If data is suspected of being bad, retake the data and review for repeatability.

If possible, correct the cause.
- If quality data cannot be collected, record this fact and the reasons, and do not collect data on that point.

5. Condition Monitoring Principles 3% - about 2 questions per exam

- Understand basic concepts of asset condition monitoring and why these strategies can be useful
- For ultrasound, recognize basic measurement trends that indicate developing machine faults. Identify changes in readings and patterns that may indicate faults.
- Understanding the failure modes of the assets that you are monitoring, will help you to understand what technology to deploy that will find those failure modes. Understand where and when ultrasound can be deployed

What other technologies are there?

- *Vibration, thermography, oil analysis an*d motor current analysis.

Why and when would ultrasound be useful?

Acceptance testing and benchmarking.

6. Applications to Machine Systems 40% - about 24 questions per exam

- Leak Detection
  - Turbulence and flow
  - Directionality
  - Measurement precautions
  - Pressurized gases and compressed air
  - Vacuum
  - Tightness testing using the ultrasonic tone method
- Valve Inspection
  - Blocked
  - Passing
  - Cavitation and flashing
- Steam Traps

    - Using ultrasound
    - Combination with temperature
    - Reporting techniques
- Electrical Inspection
    - Corona, tracking and arcing
    - Internal partial discharges
    - Safety concerns
- Hydraulic Systems Inspection
    - Cylinders, valves, and pumps
- On-Condition Bearing Lubrication
    - Trending values
    - Ultrasonic lubrication process considerations
    - Under and over-lubricated bearings
- Bearing defect detection
- Slow speed bearing inspection
- Gearbox inspection
- Pump inspection (bearings & cavitation)
- Motor inspection and the effect of variable speed drives

7. Severity Determination 10% - about 6 questions per exam

- Setting up decibel alarms
- Trending decibels
- Statistical alarm creation
- Time signal analysis
- Spectrum analysis
- Diagnosis and prognosis

8. Program Implementation 3% - about 2 questions per exam

- Routine inspection considerations
- Routine management
- Report structuring
- Corrective action for alarm incidences

9. Reporting and Corrective Action 3% - about 2 questions per exam

- Key information needed
- Recommending corrective action

- Tracking corrective action outcome

10. *Personal Safety 3% -* *about 2 questions per exam*

- Poor access to test point
- Potential for tripping the unit
- Missing or loose guards
- Possibility of steam burn, etc.
- Leaks of oil, water, steam, H2S, NH3, etc.
- Lockout Tagout if needed

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