1.2 Design and conduct quantitative assessments using appropriate instrumentation and standards

Learning Outcome

The learner should be able to plan, conduct and interpret quantitative assessments of physical-agent exposure using appropriate instruments, recognised measurement methods and relevant exposure standards. The purpose is to obtain reliable exposure data that can be used to determine risk, evaluate compliance and support control decisions.

1. Purpose of Quantitative Assessment

Quantitative assessment means measuring the level or magnitude of a physical agent rather than relying only on observation or subjective judgement.

For example:

- Noise → sound level/exposure measurement.
- Hand-arm vibration → vibration magnitude and exposure duration.
- Whole-body vibration → vibration exposure assessment.
- Heat → temperature and thermal stress measurements.
- Radiation → appropriate radiation measurement based on the type and source.

The basic process is:

Hazard identification → assessment planning → instrument selection → calibration → measurement → data validation → interpretation → risk/control decision

Quantitative assessment is particularly important when exposure levels need to be compared with legal or professional exposure criteria.

2. Selecting Appropriate Instrumentation

Examples

Physical agent	Typical instrumentation
Noise	Sound level meter, personal noise dosimeter
Hand-arm vibration	Hand-arm vibration meter/analyser
Whole-body vibration	Accelerometer/vibration meter
Heat stress	WBGT or other appropriate thermal-environment instruments
Ionising radiation	Appropriate radiation survey/dosimetry equipment
Optical radiation	Radiation-specific meters/detectors

2. Selecting Appropriate Instrumentation

Instrument selection should consider:

- Measurement range.
- Accuracy.
- Frequency response.
- Resolution.
- Environmental suitability.
- Calibration requirements.
- Whether personal or area measurement is required.
- Compatibility with the applicable measurement standard.

Using an inappropriate instrument can produce data that appear precise but are not valid for the assessment objective.

3. Applying Appropriate Measurement Standards

Quantitative assessment should be conducted using a recognised and appropriate technical method.
For example, ISO 9612:2025 provides a methodology for determining occupational noise exposure and includes different measurement strategies and consideration of measurement uncertainty. ISO
For hand-arm vibration, ISO 5349-1 provides general requirements for measuring and evaluating human exposure to hand-transmitted vibration.
For whole-body vibration, ISO 2631-1 provides general requirements for evaluating human exposure to whole-body vibration.
For thermal stress, ISO 7243 provides a WBGT-based method for assessing heat stress in occupational environments.

The important principle is:
The instrument and measurement procedure must be selected together with the applicable standard, not independently of it.

4. Planning the Assessment

Before taking measurements, the occupational hygienist should establish:
What is being measured?
For example, an operator's daily noise exposure.
Why is it being measured?
Possible objectives include:

- Initial risk assessment.
- Compliance assessment.
- Investigation of suspected overexposure.
- Verification of controls.
- Health-surveillance support.
- Evaluation following process changes.

4. Planning the Assessment

Who should be measured?

Workers should be grouped according to their exposure patterns, such as Similar Exposure Groups (SEGs) where appropriate.

When should measurements be taken?

Measurements should represent normal exposure and, where justified, relevant worst-case conditions.

Consider:

- Different shifts.
- Different tasks.
- Production variations.
- Worker activities.
- Peak or short-duration exposures.
- Changes in equipment or processes.

Poor planning can produce technically accurate measurements that nevertheless do not represent actual worker exposure.

5. Calibration and Instrument Verification

Calibration is essential for confidence in quantitative measurements.
The practitioner should ensure that:

- Equipment is within its calibration period.
- Appropriate pre-use checks are completed.
- Field calibration/verification is performed where required.
- The instrument is configured correctly.
- Post-measurement checks are completed where applicable.

For example, a noise measurement should not simply record the instrument reading. The assessor should document the instrument used, its calibration status, measurement period and relevant settings. Calibration provides evidence that the measurement system was functioning appropriately and helps identify changes in instrument response.

6. Conducting the Measurement

The measurement procedure should follow the selected technical method.
For personal exposure monitoring, the instrument should be positioned so that it reasonably represents the worker's exposure without interfering with normal work.
The assessor should record relevant contextual information such as:

- Worker and job/task.
- Date and time.
- Location.
- Equipment/process involved.
- Exposure duration.
- Instrument identification.
- Calibration information.
- Environmental or operational conditions.
- Any unusual events during measurement.

This information is essential when the results are later interpreted.

7. Data Validity and Reliability

Validity asks:

Did the assessment actually measure what it was intended to measure?

For example, measuring noise beside a machine when the objective is to determine a worker's daily personal exposure may not provide a valid representation of that worker's exposure.

Reliability

Reliability concerns whether the measurement process would produce reasonably consistent results under comparable conditions.

Reliability can be affected by:

- Instrument condition.
- Calibration.
- Sampling duration.
- Sampling position.
- Operator technique.
- Changing workplace conditions.
- Incorrect instrument settings.

A result should therefore never be interpreted without considering the quality of the measurement process.

8. Measurement Uncertainty

Quantitative measurements are not perfectly exact.
Uncertainty may arise from:

- Instrument accuracy.
- Calibration uncertainty.
- Sampling variability.
- Environmental changes.
- Worker behaviour.
- Analytical or processing methods.
- Limited sampling duration.

ISO 9612:2025, for example, specifically includes methods for estimating uncertainty in occupational noise exposure measurements. ISO
The occupational hygienist should therefore avoid presenting a measurement result as an absolute certainty. Where results are close to an exposure criterion, uncertainty becomes especially important when deciding whether additional monitoring or precautionary action is appropriate.

9. Practical Example – Noise Assessment

A manufacturing worker operates several noisy machines during a shift.
A suitable quantitative assessment would involve:
1. Identify the Similar Exposure Group
Machine operators with comparable exposure patterns.
2. Select the instrument
An appropriate personal noise dosimeter or other suitable equipment.
3. Verify/calibrate the equipment
Complete required checks before measurement.
4. Observe the work
Record tasks, duration and changes in exposure conditions.
5. Conduct representative measurements
Capture the worker's exposure across relevant activities.
6. Record contextual information
Document equipment, shift, tasks and unusual events.

9. Practical Example – Noise Assessment

7. Apply the relevant standard
Use the appropriate methodology for calculating and interpreting occupational noise exposure.
8. Evaluate the result
Compare the calculated exposure with the applicable legal/professional criteria.
9. Decide on further action
Determine whether additional monitoring, improved controls or reassessment is required.

Critical Evaluation

The quality of a quantitative assessment depends on both the instrument and the assessment strategy.

A sophisticated instrument cannot compensate for:

- Poor sampling strategy.
- Non-representative measurements.
- Incorrect positioning.
- Inadequate calibration.
- Insufficient sampling duration.
- Failure to account for exposure variability.

Therefore, quantitative assessment should be viewed as a measurement system, not simply the act of taking a reading.

The strongest assessment combines:

Appropriate instrument + recognised method + competent measurement + reliable data + appropriate interpretation.

Key Takeaways

- Quantitative assessment provides objective evidence of physical-agent exposure.
- Instrument selection must be based on the hazard, measurement objective and applicable standard.
- Measurements must be properly planned, calibrated, representative and documented.
- Data should be evaluated for validity, reliability and uncertainty.
- Quantitative results should ultimately support compliance decisions, risk assessment and control improvement.

Thank you