SmartNote: Risk-based approach to selecting environmental monitoring locations

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Part 1: What do we want to achieve with our environmental monitoring program?

Introduction

Environmental monitoring is an important part of quality assurance. While establishing environmental control is of great importance, facilities need to verify control through a comprehensive monitoring program. One aspect of this is with selecting appropriate locations for monitoring. Although each manufacturing facility is unique, in terms of type of process technology; room sizes; number of personnel present for a given activity; the overall design and so on, there is a commonality in terms of adopting a risk-based approach.

By selecting appropriate locations, the environmental monitoring program will support:

- Demonstrating that environment quality is consistently within specified levels.
- Providing a timely and sensitive warning of drifts in environmental quality, through trending.
- Initiating courses of action when environmental monitoring results are out-of-limits or out-of-trend, based on an understanding of the significance of the location.

Risk assessment

Risk-based approaches to environmental monitoring look for and assess hazards. A hazard is the potential source of harm (it is the assessment of risk that quantifies or qualifies a hazard). Particulate and microbiological hazards include biological agents that can adulterate a product.

Of particular concern are extrinsic hazards, including the bioburden present on personnel; contamination carried in the air; items transferred into the cleanroom; or microorganisms resident in a water source that enters an item of equipment. The risk from extrinsic hazards is arguably greater than that from intrinsic hazards.

The risk from extrinsic hazards involves the following steps:

- Risk of ingress;
- Risk of accessing;
- Risk of contaminating;
- Risk of being retained.

The two primary transfer mechanisms of contamination hazards are:

- Direct surface-to-surface transfer (such as, by personnel directly touching the product or contaminated water entering the process).
- Airborne transfer.

Probabilistic risk assessment is based on an expression between severity and probability:

- The magnitude (severity) of the possible adverse consequence(s), and
- The likelihood (probability) of occurrence of each consequence.

References to risk assessment occur frequently in regulatory documents, especially in Annex 1, PIC/S and EU GMP.

There are different tools that can be used for risk assessment. One of the tools of use for risk managing environmental monitoring is Hazard Analysis and Critical Control Points (HACCP). This approach maps a process, pinpoints critical control points, and establishes critical limits for the control points.

The diagram below summarizes the best approach to HACCP risk assessment:

Source: Tim Sandle

Locations for monitoring

Selecting appropriate locations for monitoring is one of the two important considerations for environmental monitoring, the other being the frequency of monitoring. When determining frequency, there needs to be a balance between monitoring at sufficiently frequent intervals, so that a meaningful picture can be obtained, and using resources adequately.

A process flow of the cleanroom should be generated using the HACCP approach. This should mark the route in of personnel and equipment and the route out of waste. Areas where open processing occur and where personnel activity is the greatest should also be marked.

Identify hazards (contamination risks), including sources and routes of contamination. Areas of potential risk include:

- Areas adjacent to the cleanroom
- Unfiltered air supply
- Room air
- Surfaces (including those likely to become contaminated)
- People (entry and areas of greatest activity)
- Machines
- Ancillary equipment
- Transfer of materials
- Containers
- Packaging
- Water sources
- Liquids
- Processing methods

Important control points to consider are areas of human activity, times when open processing takes place, locations near entry/exit doors and transfer pass-through boxes, proximity of operations to the product, and material/personnel traffic and flow patterns.

Process stages should also be taken into account, such as:

- Manufacturing process – This includes the complete manufacturing method of producing a formulated product within the cleanroom areas. For example, mixing a bulk, blending, filling vials, freeze drying and so on.
- Manufacturing stage – This includes focusing on a specific part of the manufacturing process. For example, vial sterilisation and depyrogenation; vial filling and capping; or vial freeze drying.
- Manufacturing operations – This includes activities associated with each individual manufacturing stage, such as the transfer of contact parts and components into critical areas, equipment and machine set up, and routine production.
- Manufacturing steps – These are the specific detailed activities associated with a particular manufacturing operation. For instance, the assembly of the vial filling head, or loading of the freeze dryer.

In the Part II of this series, *Putting environmental monitoring theory into practice*, we will look at some practical examples »

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