INTERNATIONAL STANDARD

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Aseptic processing of health care products —

Part 5: Sterilization in place

Traitement aseptique des produits de santé —

Partie 5: Stérilisation sur place

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13408-5 was prepared by Technical Committee ISO/TC 198, *Sterilization of health care products*.

ISO 13408 consists of the following parts, under the general title *Aseptic processing of health care products*:

— *Part 1: General requirements*

— *Part 2: Filtration*

— *Part 3: Lyophilization*

— *Part 4: Clean-in-place technologies*

— *Part 5: Sterilization in place*

— *Part 6: Isolator systems*

Introduction

During the process of preparing ISO 13408-1, several items, e.g. filtration, freeze drying and sterilization in place, were found to be in need of supplementary information which was too voluminous to be given in corresponding annexes.

This part of ISO 13408 includes requirements and guidance that are to be observed during sterilization in place. The purpose of this part of ISO 13408 is to achieve standardization in the field of validation and routine control of sterilization in place processes used in the manufacture of health care products.

Sterilization in place is, in most instances, preceded by cleaning in place which is described in ISO 13408-4. While methods of cleaning in place and sterilization in place differ considerably in technology, the concept of *in situ* treatment is similar.

The most important issue to consider in establishing sterilization-in-place technology is the design of the system(s) to ensure that they be able to successfully sterilize manufacturing equipment to the desired level of sterility assurance.

Aseptic processing of health care products —

Part 5:
Sterilization in place

1 Scope

1.1 This part of ISO 13408 specifies the general requirements for sterilization in place (SIP) applied to product contact surfaces of the equipment used in the manufacture of sterile health care products by aseptic processing and offers guidance on qualification, validation, operation and control.

NOTE SIP can be achieved by using steam or other gaseous or liquid sterilizing agents. Specific guidance on steam sterilization in place, which is the most common method used, is given in Annex A.

1.2 This part of ISO 13408 applies to processes where sterilizing agents are delivered to the internal surfaces of equipment that can come in contact with the product.

1.3 This part of ISO 13408 does not apply to processes where equipment is dismantled and delivered to a sterilizer.

1.4 This part of ISO 13408 does not supersede or replace national regulatory requirements, such as Good Manufacturing Practices (GMPs) and/or compendial requirements that pertain in particular national or regional jurisdictions.

1.5 This part of ISO 13408 does not specify requirements for development, validation and routine control of a process for inactivating the causative agents of spongiform encephalopathies, such as scrapie, bovine spongiform encephalopathy and Creutzfeldt-Jakob disease. Specific recommendations have been produced in particular countries for the processing of materials potentially contaminated with these agents.

NOTE See also ISO 22442-1, ISO 22442-2 and ISO 22442-3.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11138 (all parts), *Sterilization of health care products — Biological indicators*

ISO 11140 (all parts), *Sterilization of health care products — Chemical indicators*

ISO 13408-1, *Aseptic processing of health care products — Part 1: General requirements*

ISO 13408-4, *Aseptic processing of health care products — Part 4: Clean-in-place technologies*

ISO 14161, *Sterilization of health care products — Biological indicators — Guidance for the selection, use and interpretation of results*

ISO 14937, *Sterilization of health care products — General requirements for characterization of a sterilizing agent and the development, validation and routine control of a sterilization process for medical devices*

ISO 17665-1, *Sterilization of health care products — Moist heat — Part 1: Requirements for the development, validation and routine control of a sterilization process for medical devices*

ISO/IEC 90003, *Software engineering — Guidelines for the application of ISO 9001:2000 to computer software*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13408-1 and the following apply.

3.1
dead leg
location which, by design, does not permit adequate accessibility of the sterilizing agent

3.2
design qualification
verification that the proposed specification for the facility, equipment or system is suitable for the intended use

[ISO/TS 11139:2006, definition 2.12]

3.3
material safety data sheet
MSDS
document specifying the properties of a substance, its potential hazardous effects for humans and the environment, and the precautions necessary to handle and dispose of the substance safely

[ISO/TS 11139:2006, definition 2.23]

3.4
process parameter
specified value for a process variable

NOTE The specification for a sterilization process includes the process parameters and their tolerances.

[ISO/TS 11139:2006, definition 2.34]

3.5
process variable
condition within a sterilization process, changes in which alter microbicidal effectiveness

EXAMPLE Time, temperature, pressure, concentration, humidity, wavelength.

[ISO/TS 11139:2006, definition 2.35]

3.6
sterilization in place
SIP
method of sterilization of the internal surfaces of parts of the equipment or an entire process system *in situ*, without disassembly, using appropriate sterilizing agents

NOTE The term “Steam in place” is used in ISO 13408-1, Clause 19, and this term is sometimes abbreviated as SIP. However, in this part of ISO 13408, “SIP” is used with a wider meaning and includes not only steam in place, but all kinds of sterilization used for the sterilization “in place” or “in situ”. In this part of ISO 13408, “Steam sterilization in place” is referred to as “Steam SIP”.

3.7
sterility assurance level
SAL
probability of a single viable microorganism occurring on an item after sterilization

NOTE 1 The term SAL takes a quantitative value, generally 10^{-6}or 10^{-3}. When applying this quantitative value to assurance of sterility, an SAL of 10^{-6} provides a greater assurance of sterility than an SAL of 10^{-3}.

[ISO/TS 11139:2006, definition 2.46]

NOTE 2 For the purposes of this part of ISO 13408, the product is considered to be product contact surfaces subject to SIP.

3.8
sterilization process
series of actions or operations needed to achieve the specified requirements for sterility

[ISO/TS 11139:2006, definition 2.49]

3.9
sterilizing agent
physical or chemical entity, or combination of entities, having sufficient microbicidal activity to achieve sterility under defined conditions

[ISO/TS 11139:2006, definition 2.50]

4 Quality system elements

4.1 General

4.1.1 The requirements of ISO 13408-1 shall apply.

4.1.2 Documented procedures for each phase of the development, validation, routine monitoring and control of the SIP process shall be prepared and implemented.

4.1.3 Documents required by this part of ISO 13408 shall be reviewed and approved by designated personnel.

4.1.4 Records of development, validation, routine control and monitoring shall be maintained to provide evidence of conformity to the requirements of this part of ISO 13408.

4.2 Management responsibility

4.2.1 The responsibilities and authority for implementing and performing the procedures described in this part of ISO 13408 shall be specified.

4.2.2 If the requirements of this part of ISO 13408 are undertaken by organizations with separate quality management systems, the responsibilities and authority of each party shall be specified.

4.3 Design control

Characterization of the sterilizing agent, sterilization process, equipment to deliver SIP and equipment to be subject to SIP shall be undertaken in accordance with a documented plan. At defined stages, design reviews shall be planned, conducted and documented.

4.4 Measuring instruments and measuring systems

4.4.1 A documented system shall be specified for the calibration of all measuring instruments or measuring systems.

4.4.2 The accuracy and tolerance of the measuring instrument shall be adequate to the process to be measured.

5 Process and equipment characterization

5.1 General concepts

5.1.1 Specifications for the SIP process shall include, but not be limited to:

a) compatibility of the equipment with the sterilizing agent(s) and processing conditions;

b) pre-requisite cleaning procedure, where necessary;

c) introduction, homogeneity, distribution and contact time with the sterilizing agent;

d) physical and/or chemical characteristics of sterilizing agent(s);

e) demonstration of the efficacy of the process;

f) sterilizing agent residuals or degradation products;

g) drying of product contact surfaces, where necessary;

h) maintenance of sterility after the completion of the process;

i) acceptable tolerances for any potential residues from the process in the product to be made in the equipment;

j) physical integrity testing and establishing limits.

5.1.2 Process parameters and their tolerances shall be specified, documented and reviewed.

5.1.3 During production processes, the sterilizing conditions achieved shall be monitored, maintained within specified tolerances, and documented throughout the duration of the sterilization process.

5.1.4 Although the entire processing system can be sterilized as a single entity in SIP, it can be advantageous to divide the system into several parts in order to simplify the sterilization procedures. When a large system is sterilized by dividing it into several segments, the segments should overlap to ensure that all portions of the system are adequately and effectively sterilized.

5.1.5 Complex sequences of opening and shutting of valves in the pipes of a system could be required. Where this is controlled manually, detailed documentation of individual steps is required. Where automation is used, electronic automation systems should be carefully designed and validated.

5.2 Effectiveness of sterilization in place (SIP)

The sterility assurance level of the process shall be established and documented. Justification of the process parameters shall be included in the documentation.

5.3 Equipment

5.3.1 Equipment to be subjected to SIP

5.3.1.1 The equipment shall be designed and manufactured to facilitate SIP and to ensure that the sterilizing agent(s) can enter all internal product contact parts of the equipment to be sterilized (such as filter housings, pipe branches, and valves).

Design considerations shall include, but not be limited to:

a) smoothness of inner surface of equipment;

b) accessibility of the sterilizing agent to all relevant surfaces;

c) correct placement of ports to admit the sterilizing agent(s) and, where applicable, to allow bleeding to facilitate sterilizing agent distribution;

d) absence of dead legs in piping systems;

e) drainability of the system (e.g. slope of piping to ensure the complete removal of remaining liquid in the system);

f) correct placement of ports to permit inclusion of process monitoring devices;

g) where applicable, exhaust port for safe removal of gaseous sterilizing agent;

h) where applicable, resistance of the equipment to pressure, vacuum and heat;

i) compatibility of materials of construction (e.g. pipes, tanks, valves, nozzles, filters, gaskets, sensors) with the sterilizing agent, over the anticipated number of sterilization cycles;

j) provisions for maintenance of sterility during and after completion of SIP (e.g. by elevated pressure).

Materials made of resin, such as gaskets, require particular attention.

Inner corners or shoulders of the tank and/or vessel of the system should be designed so that they do not entrap air and thereby cause incomplete sterilization in the resulting air pocket.

Valves, connections and other equipment (such as heat exchangers) should be designed and oriented to reduce the inaccessible surfaces and entrapment of air.

5.3.1.2 Specification of the equipment shall include, but not be limited to:

a) physical description of the equipment, together with any necessary ancillary items (including materials of construction and “as-built” drawings);

b) specifications of the sterilizing agent and means by which it is provided, including any additives or precursors necessary for its delivery;

c) description of instrumentation for monitoring and controlling the sterilization process, including sensor characteristics and their locations, indicating instruments and recording instruments;

NOTE Temperature monitoring will normally be at the slowest-to-heat locations.

d) description of safety features, including those for personnel and environmental protection;

e) description of installation requirements, if applicable;

f) documented evidence that the software used to control and/or monitor the process is prepared in accordance with a quality system and that the software meets its design intention;

g) a process flow diagram that outlines the processing equipment layout to be sterilized, including valve sequencing.

5.3.2 Equipment to be used for SIP

5.3.2.1 The equipment shall be designed and manufactured to effectively perform and control SIP of the equipment to be sterilized. Its primary functions to be verified in qualification shall include but not be limited to:

a) generation of the sterilizing agent, where applicable;

b) admittance of the sterilizing agent into the equipment to be sterilized in a controlled and safe manner;

c) distribution of the sterilizing agent within the equipment to be sterilized;

d) maintenance of effective sterilization conditions throughout the equipment to be sterilized;

e) controlling and monitoring of the sterilization conditions in the defined locations;

f) safe removal of the sterilizing agent;

g) maintenance of the sterility of the equipment.

5.3.2.2 Specification of the equipment shall include at least:

a) a physical description of the equipment, together with any necessary ancillary items, including materials of construction and “as-built” drawings;

b) a specification of the sterilizing agent and means by which it is provided, including any additives or precursors necessary for its delivery;

c) a description of instrumentation for monitoring, controlling and recording the sterilization process, including sensor characteristics, tolerances and locations;

d) a description of safety features, including those for personnel and environmental protection;

e) a description of installation requirements, if applicable; this should include the location and the environment in which the equipment is to be installed and the services that are required for SIP and for the area in which the SIP system is installed;

f) documented evidence that the software used to control and/or monitor the process is prepared in accordance with a quality system and that the software meets its design intention.

5.3.3 Failure detection

Means shall be provided to ensure that a failure in a control function does not lead to a failure in recording of process parameters such that an ineffective process appears effective.

This can be achieved, either through the use of independent systems for control and monitoring, or through a crosscheck between control and monitoring, which identifies any discrepancies and indicates a fault.

6 Sterilizing agent characterization

6.1 Selection of sterilizing agent(s)

6.1.1 The sterilizing agent used shall be compatible with the equipment, shall not leave objectionable residues and shall be capable of delivering the stated sterility assurance level within specified sterilization parameters.

6.1.2 In selecting sterilizing agents, due consideration should be given to the potential for interactions with product residue (see ISO 13408-4).

6.2 Quality of sterilizing agent(s)

6.2.1 Data shall be available to demonstrate the microbicidal effectiveness of the sterilizing agent.

6.2.2 A specification including purity for the sterilizing agent shall be established and documented.

6.3 Safety and the environment

6.3.1 A material safety data sheet or analogous safety information for the sterilizing agent shall be available.

6.3.2 An assessment of the potential environmental impact shall be available for any sterilizing agent other than steam.

7 SIP process

7.1 Process parameters

7.1.1 Process parameters as justified in 5.2, including their minimum and maximum limits, shall be defined and documented. Process parameters shall be adequate to ensure sterilization of the equipment being subjected to SIP.

7.1.2 Such parameters shall include, but not be limited to, where applicable:

a) number of evacuation cycles and their variables;

b) concentration of sterilizing agent;

c) humidity, temperature, pressure;

d) time at sterilizing conditions;

e) maintenance of sterilizing conditions (e.g. constant replacement of inactivated sterilizing agent, integrity testing of vent filters, positive pressure);

f) type of sterile purging medium, and the time, flow rate and temperature required to purge and dry the system after assembly.

7.1.3 Means of monitoring and controlling the process variables shall be defined and documented.

7.2 Cycle development

7.2.1 Prerequisite information for the sterilization process, such as effectiveness on microbial challenge organisms and determination of lethality, shall be obtained. The SIP process shall be designed and developed based on this information.

7.2.2 Sterilization operational procedures shall be established and the process parameters required to meet validated sterilization conditions shall be defined.

7.2.3 All operational procedures shall be established as written procedures and shall be followed.

7.2.4 The most-difficult-to-sterilize locations within the equipment to be sterilized shall be determined and it shall be demonstrated that, at these locations, sterilization is effective to the pre-determined acceptable level.

NOTE This can include occluded surfaces or spaces where sterilizing conditions are the most difficult to attain.

8 Validation

8.1 Validation protocol

Written protocol(s) shall be established specifying how qualification and validation are to be conducted. Protocol(s) specifying critical steps and acceptance criteria shall be reviewed and approved. Qualification of equipment design, installation, operation and performance shall be performed in accordance with the approved protocol(s). Any deviation(s) from the protocol(s) shall be documented, investigated and resolved.

8.2 Design qualification

The SIP system shall be designed for its intended use. The appropriateness of system design, process design, design of all facilities, equipment and materials used shall, at the first stage of validation, be confirmed to meet requirements for the intended use.

8.3 Installation qualification

8.3.1 General

Installation qualification shall be performed to demonstrate that equipment used to perform SIP and deliver the sterilizing agent, equipment to be subjected to SIP, and any ancillary items, have been supplied in accordance with their specifications.

8.3.2 Installation

8.3.2.1 It shall be verified that:

a) the location of the equipment conforms to its specification;

b) the equipment is installed in accordance with installation instructions;

c) the services to the equipment conform to their specification.

8.3.2.2 The calibration of all measuring instruments critical to the process (including any test instruments) used for monitoring, controlling, indicating or recording shall be confirmed. Alternatively, calibration may be confirmed at the commencement of operational qualification.

8.3.2.3 Computerized control systems and associated software, when installed, shall be qualified to demonstrate conformance to ISO/IEC 90003 or other relevant guidelines for the manufacture of the product.

8.4 Operational qualification

8.4.1 Operational qualification shall demonstrate that the installed equipment is capable of performing the specified SIP process throughout the equipment within defined tolerances.

8.4.2 The operating procedures for the equipment shall be verified to meet established requirements. These operating procedures shall include, but not be limited to:

a) step-by-step operating instructions;

b) the method by which a failure to attain the operating cycle parameters can be identified, and the actions to be taken;

c) housekeeping, calibration and maintenance instructions;

d) the means by which an error in the result of a measurement for control, indication and recording can be identified;

e) details of contacts for technical support.

8.4.3 The potential most-difficult-to-sterilize locations of the equipment shall be determined by taking into consideration the individual physical and/or chemical properties of the sterilizing agent and the inactivation characteristics of the sterilization process.

NOTE Dead legs and shoulder of tanks can be regarded as potential worst case locations.

8.4.4 Data shall be generated to verify that the defined sterilizing conditions (e.g. time, pressure, temperature, concentration of sterilizing agent and its distribution) are attained within specified tolerances throughout the SIP system.

8.4.5 The consequences of failure in the result from each measuring instrument fitted to the SIP system (control, indication and recording) shall be determined at significant parts of the SIP process.

8.4.6 The number and locations of sensors used for qualification, such as temperature and pressure, shall be specified. Documented evidence shall be provided to show that the number and locations used are sufficient to demonstrate that the requirements for SIP of the equipment have been met.

8.5 Performance qualification

8.5.1 General requirements

8.5.1.1 Data generated during installation qualification and operational qualification shall be approved before performance qualification is started.

8.5.1.2 The manner of presenting the equipment for sterilization shall be established and documented (see ISO 14937).

8.5.1.3 Data shall be generated to demonstrate the attainment of the defined physical and/or chemical conditions, within the specified tolerances throughout processing. The appropriateness of any routine monitoring positions or devices shall be established. This is achieved by mapping the attainment of the specified condition(s) at representative points throughout processing. See ISO 14937.

8.5.1.4 Performance qualification shall include a comparison and evaluation of process parameters measured in the SIP process to those provided at the time of the SIP system's design. The acceptability of any deviation from those specified at the time of design shall be confirmed by reference to existing data and tests.

8.5.1.5 Documented evidence shall be provided to show that the number of critical parameter sensors for performance qualification is sufficient to demonstrate compliance with the specification for SIP of the equipment.

8.5.1.6 Biological indicators or inoculated carriers shall be used during the performance qualification. They shall comply with ISO 11138-1 and any other appropriate part of ISO 11138, as applicable (see ISO 14937). The number and locations of biological indicators shall be specified. Documented evidence shall be provided to show that the number and locations of biological indicators are sufficient to demonstrate that the requirements for SIP of the equipment have been met at locations presenting the greatest sterilization challenge.

8.5.1.7 If chemical indicators are used as a part of the performance qualification, they shall comply with ISO 11140-1 and any other appropriate part of ISO 11140 as applicable (see ISO 14937). The number and locations of chemical indicators shall be specified. Documented evidence shall be provided to show that the number and locations of chemical indicators are sufficient to demonstrate that the requirements for SIP of the equipment have been met at locations presenting the greatest sterilization challenge.

8.5.1.8 Performance qualification shall include a series of at least three consecutive and successful runs of the SIP process to demonstrate the reproducibility and effectiveness of the process. The successful SIP runs shall be determined by measurement of physical parameters and inactivation of biological indicators or inoculated carriers which shall demonstrate the required microbicidal effectiveness.

8.5.1.9 If a failure of a run (see 8.5.1.8) can be attributed to factors not relevant to the effectiveness of the SIP process being validated, this test may be documented as unrelated to the performance of the SIP process without requiring three further consecutive, successful runs.

NOTE Examples of this type of failure include, but are not limited to, power failures, loss of services or failure of external monitoring equipment (see ISO 14937).

8.5.2 Microbicidal effectiveness

Microbicidal effectiveness studies shall achieve the following.

a) Demonstrate that the lethality of the sterilizing agent against resistant microbial challenge organisms is sufficient to achieve a SAL of 10^{-6}.

   NOTE 1 This can be demonstrated by showing total kill of an appropriate resistant biological indicator to the sterilization condition in a fractional cycle.

   One or more biological model systems may be used for the validation of the effectiveness of the cycle. The selection of the microorganisms should be based on cycle characteristics and on worst case considerations. Justification for the choice of test microorganisms should be documented.

b) Establish that there is an empirical mathematical relationship defining the microbial inactivation kinetics of identified resistant microorganisms, and confirm that the lethal action can be extrapolated to predict the probability of a microorganism surviving when exposed to a defined treatment.

   The characteristics of the organism used to demonstrate the microbicidal effectiveness of the process when exposed to the sterilizing agent under specific conditions (such as D-value, population) should be determined (either by testing or by vendor certification) and documented. The test method(s), acceptance criteria, and test results should be documented (see ISO 14161).

c) Identify the process variables that can adversely affect the lethal action of the sterilizing agent.

d) Assess factors that can adversely affect the delivery and/or distribution of the sterilizing agent.

NOTE 2 Such factors can include, for example, interactions with materials and residues, degradation products or inactivated product generated from the sterilizing agent, such as condensate water generated from steam, and degradants resulting from manufacturing, cleaning and/or disinfection.

8.6 Review and approval of validation

8.6.1 Information gathered or produced during design qualification, installation qualification, operational qualification and performance qualification shall be documented and reviewed for acceptability. The results of this review shall be documented.

8.6.2 A complete process specification, including the process parameters and their tolerances shall be confirmed. This process specification shall also include the criteria for designating an individual SIP process as conforming to acceptance criteria.

8.6.3 A validation report(s) shall be generated. The report(s) shall be signed by persons designated as responsible for preparing, reviewing and accepting this (these) report(s) against the acceptance criteria provided in the validation protocol(s).

8.6.4 The validation report(s) shall include a verification that all gauges, recorders etc., were within calibration at the time of the performance qualification.

8.7 Requalification

8.7.1 Requalification of processes carried out with specified equipment shall be performed at defined intervals and in response to SIP failures.

8.7.2 SIP process data shall be reviewed periodically against specified acceptance criteria in accordance with documented procedures. Records of reviews of revalidation data and corrective actions taken in the event that the specified acceptance criteria were not met shall be retained.

8.7.3 Requalification report(s) shall be documented and retained.

9 Routine monitoring and control

9.1 SIP process control

Routine monitoring and control shall be performed on each SIP process. Data shall be recorded to demonstrate that the validated and specified SIP process parameters have been delivered to the system.

9.2 Procedures

Written procedures shall be consistent with those of validation studies. These procedures shall include, but not be limited to:

a) step-by-step operating instructions;

b) duties and responsibilities;

c) acceptance criteria for the operating cycle parameters and actions to be taken if those criteria have not been met;

d) the means by which the error in the result of a measurement for control, indication and recording can be identified;

e) detailed description of the SIP process;

f) housekeeping, calibration and maintenance instructions;

g) details of contacts for technical support.

9.3 SIP process records

9.3.1 SIP process records shall include, but not be limited to:

a) date of operation;

b) identification and cycle number of SIP process;

c) operator identification;

d) SIP process parameters and their confirmation.

NOTE Records can include, for example, an equipment printout of critical parameters (e.g. contact time, temperature, and pressure measured at predetermined positions).

9.3.2 Additional evidence may be supplied (by biological or chemical indicators) that the sterilization process was delivered within the defined tolerances.

9.3.3 SIP process records shall be reviewed and accepted prior to the manufacturing of the next batch.

9.4 Change control

9.4.1 Changes to equipment, sterilization agent(s), process parameters or product processed on the equipment shall be assessed for the potential impact on the effectiveness of the SIP process and the need of requalification.

9.4.2 The magnitude of the change should be considered in determining the extent to which installation qualification, operational qualification or performance qualification is undertaken.

9.4.3 The outcome of the assessment, including the rationale for decisions reached and the extent of qualification that is necessary, shall be documented.

9.5 Maintenance of equipment

Preventative maintenance shall be planned and performed in accordance with documented procedures.

10 Personnel training

10.1 Personnel shall be trained according to the established procedures.

10.2 A specific training programme for personnel shall be established, implemented and documented. Training shall demonstrate personnel's:

a) understanding the principles of the process, including operational and construction features;

b) ability to perform the routine operation, maintenance or testing, as appropriate;

c) understanding of the actions to be taken if the process or any part of process fails;

d) understanding of the safety aspects of the sterilizing agent(s) and SIP system.