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Global Harmonization Working Party

Towards Medical Device Harmonization

PROPOSED FINAL DOCUMENT

Title:	Medical Gas System (MGS) – Essential Principles of Safety and Performance (EPSP) – Standards for Demonstrating Compliance
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Preface

This Guidance Document was developed by Global Harmonization Working Party (GHWP), Working Group 8 on Standards. GHWP is a voluntary group of representatives from medical device regulatory authorities and the regulated industry. The document is intended to provide non-binding guidance for use in the regulation of medical devices, and subject to consultation throughout its development process.

This Guidance Document shall be read in conjunction with the current laws and regulations used in member economies.

In this Guidance Document, the following verbal forms are used:

— “shall” indicates a requirement;

— “should” indicates a recommendation;

— “may” indicates a permission; and

— “can” indicates a possibility or a capability.

0 Introduction

Medical gases are used for healthcare purposes in different ways. Some are gases for medicinal use (considered as a drug), medical device gas (considered as a medical device) and inflating gas (classified as a medical device or a drug based on its primary mode of action). The medical gas system (MGS) is an essential part of any healthcare facility, a failure of which can contribute to the morbidity and/or death of the patient. MGS has inherent multiple risks to the patients, operators and person at the healthcare facility.

It is essential that all elements such as the design, manufacturing and installation of MGS intended to be placed in member economies meet the standards of safety, quality and performance.

Regulatory controls are intended to safeguard the health and safety of patients, users and others by ensuring that manufacturers of medical devices follow specified procedures during design, manufacture and marketing. Consistent identification, selection and application of safety and performance criteria to a medical device offers significant benefits to the manufacturer, user, patient or consumer, and to Regulatory Authorities since it allows its manufacturer to design, manufacture and demonstrate that the device is suitable for its intended use. It is the responsibility of the manufacturer to demonstrate that its medical device is safe and perform as its intended use based on essential safety and performance criteria for a medical device.

This guidance document provides a list of standards for the medical gas system that can be used for regulatory submissions to demonstrate compliance to established essential safety and performance elements.

1 Scope

This document provide guidance on standards for the medical gas system that can be used to demonstrate compliance to Essential Principles of Safety and Performance (EPSP).

The scope of this document does not cover the specific use of medical gas but only the supply system.

The EPSP referenced in this guidance document have been adopted from IMDRF/GRRP WG/N47FINAL:2018, *Essential Principles of Safety and Performance of Medical Devices and IVD Medical Devices*.

2 References

The following document is referred to in the text in such a way that some or all of their content constitutes requirements 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.

IMDRF/GRRP WG/N47FINAL:2018, *Essential Principles of Safety and Performance of Medical Devices and IVD Medical Devices*

3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

3.1 essential principles
essential principles of safety and performance

fundamental high-level requirements that when complied with ensure a medical device is safe and performs as intended

3.2 gas for medicinal use

gas or mixture of gases that can be used either with a view to restore, correct or modify physiological functions by exerting a pharmacological, immunological or metabolic action, or to make a medical diagnosis

[Source: ISO 4135:2022, 3.1.1.17]

3.3 medical device gas

gas or mixture of gases intended by the manufacturer to be used as a medical device or as an accessory to a medical device

Note 1 to entry: This encompasses uses for investigation or modification of the anatomy or of a physiological process, and which does not achieve its principal intended action by pharmacological, immunological or metabolic means, in or on the human body, but which may be assisted in its function by such means.

Note 2 to entry: In some countries, medical device gases may be regulated as a medical device, a drug or not subject to regulation.

EXAMPLE 1 Liquid gases used for cryoablation.
EXAMPLE 2 Gases used to provide an anaerobic atmosphere.
EXAMPLE 3 Compressed air for hyperbaric chambers.
EXAMPLE 4 Driving gas for surgical tools.
EXAMPLE 5 Inflating gases for laparoscopy.

[Source: ISO 4135:2022, 3.1.1.19]

3.4 medical gas

any gas or mixture of gases intended for administration to patients for anaesthetic, therapeutic, diagnostic or prophylactic purposes, or as a source of pneumatic power for medical or surgical tools

[Source: ISO 4135:2022, 3.1.1.20]

3.5 medical gas system

complete system which comprises a supply system, a monitoring and alarm system and a distribution system with terminal units at the points where medical gases or vacuum are required

[Source: ISO 7396-1:2016, 3.36]

4 Essential Principles of Safety and Performance (EPSP)

EPSP of medical device should be considered during the design and manufacturing process. Depending on the particular medical device, some of the essential principles of safety and performance do not apply. In those cases, justifications should be provided for their exclusion.

4.1 In order to demonstrate the compliance of EPSP, some examples of documentation/evidence are as follows:

- risk management file including benefit-risk analysis
- clinical evaluation including literature review
- design and manufacturing information
- list of applicable standards used
- product verification and validation
- information to be provided by the manufacturer including labeling
- post-market surveillance plan

Not all the essential principles will be applicable to all devices and it is for the manufacturer of the device to assess which are appropriate for his particular device. The checklist of EPSP presented in Annex A of this document may be applicable for the types of medical gas systems referenced in Annex B.

5. Standards for demonstrating compliance

As outlined in the IMDRF N47 document, consensus standards that contain detailed requirements may be used to demonstrate conformance with the essential principles of safety and performance. Such consensus standards provide a greater level of detail and specificity than can be expressed in the essential principles. The essential principles of safety and performance and their related standards can be useful in the fulfilment of pre-market and post-market requirements throughout the lifecycle of a medical gas system.

Annex A, builds up on the work contained in the IMDRF N47 guidance to include the relevant standards of a MGS that are referenced in this guidance.

Annex B references the standards that the manufacturer of medical gas system may use to demonstrate conformity with the Essential Principles. Such standards are referenced according to their use and relationship to the medical gas system (in supply or distribution area) or related equipment.

Any other equivalent evidence like industrial standards (specifications), manufacturer-developed Standard Operating Procedures, non-recognized standards, and state-of-the-art techniques can be used to demonstrate compliance to the Essential Principles.

Annex A

Table relating EPSP to MGS standards

The table below is intended to provide general guidance for meeting the essential principles of safety and performance for a medical gas system. The standards below are not intended to encompass all of the requirements to meet a particular essential principle, but rather provide some overarching guidance. Depending on the specific medical gas system, additional product specific standards may need to be used. In addition, the requirements of the particular Regulatory Authority having jurisdiction must also be taken into consideration.

Note. For undated references, the latest edition of the referenced documents/standards (including any amendments) applies.

Clause - IMDRF/ GRRP WG/N47	Essential Principles of Safety and Performance of Medical Devices	Relevant Standards
5.0 Essential Principles Applicable to all Medical Devices and IVD Medical Devices		
5.1	**General** 5.1.1 Medical devices and IVD medical devices should achieve the performance intended by their manufacturer and should be designed and manufactured in such a way that, during intended conditions of use, they are suitable for their intended purpose. They should be safe and perform as intended, should have risks that are acceptable when weighed against the benefits to the patient, and should not compromise the clinical condition or the safety of patients, or the safety and health of users or, where applicable, other persons. 5.1.2 Manufacturers should establish, implement, document and maintain a risk management system to ensure the ongoing quality, safety and performance of the medical device and IVD medical device. Risk management should be understood as a continuous iterative process throughout the entire lifecycle of a medical device and IVD medical device, requiring regular systematic updating. In carrying out risk management manufacturers should: a) establish and document a risk management plan covering each medical device and IVD medical device; b) identify and analyze the known and foreseeable hazards associated with each medical device and IVD medical device; c) estimate and evaluate the risks associated with, and occurring during, the intended use and during reasonably foreseeable misuse; d) eliminate or control the risks referred to in point (c) in accordance with the requirements of points 5.1.3 and 5.1.4 below;	ISO 13485 ISO 14971 ISO 14155 IEC 62366-1 IEC 60812 IEC 60601-1-8 ISO 12500 ISO 10993 (all parts) ISO 10961 ISO 7396 (all parts) ISO 10524 (all parts)

e) evaluate the impact of information from the production and postproduction phases, on the overall risk, benefit-risk determination and risk acceptability. This evaluation should include the impact of the presence of previously unrecognized hazards or hazardous situations, the acceptability of the estimated risk(s) arising from a hazardous situation, and changes to the generally acknowledged state of the art.

f) based on the evaluation of the impact of the information referred to in point (e), if necessary amend control measures in line with the requirements of points 5.1.3 and 5.1.4 below.

5.1.3 Risk control measures adopted by manufacturers for the design and manufacture of the medical device and IVD medical device should conform to safety principles, taking account of the generally acknowledged state of the art. When risk reduction is required, manufacturers should control risks so that the residual risk associated with each hazard as well as the overall residual risk is judged acceptable. In selecting the most appropriate solutions, manufacturers should, in the following order of priority:

a) eliminate or appropriately reduce risks through safe design and manufacture;

b) where appropriate, take adequate protection measures, including alarms if necessary, in relation to risks that cannot be eliminated; and

c) provide information for safety (warnings/precautions/contra-indications) and, where appropriate, training to users.

5.1.4 The manufacturer should inform users of any relevant residual risks.

5.1.5 In eliminating or reducing risks related to use, the manufacturer should:

a) appropriately reduce the risks related to the features of the medical device and IVD medical device and the environment in which the medical device and IVD medical device are intended to be used (e.g. ergonomic/usability features, tolerance to dust and humidity) and

b) give consideration to the technical knowledge, experience, education, training and use environment and, where applicable, the medical and physical conditions of intended users.

5.1.6 The characteristics and performance of a medical device and IVD medical device should not be adversely affected to such a degree that the health or safety of the patient and the user and, where applicable, of other persons are compromised during the expected life of the device, as specified by the manufacturer, when the medical device and IVD medical device is subjected to the stresses which can occur during normal conditions of use and has been properly maintained and calibrated (if applicable) in accordance with the manufacturer's instructions.

	5.1.7 Medical devices and IVD medical devices should be designed, manufactured and packaged in such a way that their characteristics and performance, including the integrity and cleanliness of the product and when used in accordance with the intended use, are not adversely affected by transport and storage (for example, through shock, vibrations, and fluctuations of temperature and humidity), taking account of the instructions and information provided by the manufacturer. The performance, safety, and sterility of the medical device and IVD medical device should be sufficiently maintained throughout any shelf-life specified by the manufacturer. 5.1.8 Medical devices and IVD medical devices should have acceptable stability during their shelf-life, during the time of use after being opened (for IVDs, including after being installed in the instrument), and during transportation or dispatch (for IVDs, including samples). 5.1.9 All known and foreseeable risks, and any undesirable side-effects, should be minimized and be acceptable when weighed against the evaluated benefits arising from the achieved performance of the device during intended conditions of use taking into account the generally acknowledged state of the art.	
5.2	**Clinical Evaluation** 5.2.1 Where appropriate and depending on jurisdictional requirements, a clinical evaluation may be required. A clinical evaluation should assess clinical data to establish that a favorable benefit-risk determination exists for the medical device and IVD medical device in the form of one or more of the following: • clinical investigation reports (for IVDs, clinical performance evaluation reports) • published scientific literature/reviews • clinical experience 5.2.2 Clinical investigations should be conducted in accordance with the ethical principles that have their origin in the Declaration of Helsinki. These principles protect the rights, safety and well-being of human subjects, which are the most important considerations and shall prevail over interests of science and society. These principles shall be understood, observed, and applied at every step in the clinical investigation. In addition, some countries may have specific regulatory requirements for pre-study protocol review, informed consent, and for IVD medical devices, use of leftover specimens.	ISO 14155
5.3	**Chemical, Physical, and Biological Properties** 5.3.1 Regarding chemical, physical, and biological properties of a medical device and IVD medical device, particular attention should be paid to the following: a) the choice of materials and substances used, particularly with respect to: • toxicity; • biocompatibility; and	ISO 10993-1 and relevant parts ISO 14971 ISO 18562 (all parts) ISO 7396-1

	• flammability; b) the impact of processes on material properties; c) where appropriate, the results of biophysical or modelling research whose validity of which has been demonstrated beforehand; d) the mechanical properties of the materials used, reflecting, where appropriate, matters such as strength, ductility, fracture resistance, wear resistance and fatigue resistance; e) surface properties; and f) the confirmation that the device meets any defined chemical and/or physical specifications. 5.3.2 Medical devices and IVD medical devices should be designed, manufactured and packaged in such a way as to minimize the risk posed by contaminants and residues to users and patients, taking account of the intended purpose of the medical device and IVD medical device, and to the persons involved in the transport, storage and use of the medical device and IVD medical device. Particular attention should be paid to tissues of users and patients exposed to those contaminants and residues and to the duration and frequency of exposure. 5.3.3 The medical device and IVD medical device should be designed and manufactured in such a way as to appropriately reduce the risks posed by substance egress (including leaching and/or evaporation), degradation products, processing residues, etc. Special attention should be given to leaking or leaching of substances, which are carcinogenic, mutagenic or toxic to reproduction. 5.3.4 The medical device and IVD medical device should be designed and manufactured in such a way as to appropriately reduce the risks posed by the unintentional ingress of substances into the device, taking into account the medical device and IVD medical device and the nature of the environment in which it is intended to be used. 5.3.5 Medical devices and IVD medical devices and their manufacturing processes should be designed in such a way as to eliminate or to appropriately reduce the risk of infection to users and all other persons who may come in contact with the medical device and IVD medical device. The design should: a) allow for easy and safe handling; b) appropriately reduce any microbial leakage from the medical device and IVD medical device and/or microbial exposure during use; c) prevent microbial contamination of the medical device and IVD medical device or its content (e.g., specimens); and/or d) appropriately reduce the risks from unintended exposure (e.g., cuts and pricks (such as needle stick injuries), eye	ISO 21969 ISO 23328-1 ISO 23328-2 ISO 15001

	splashes, etc.).	
5.4	**Sterilization and Microbial Contamination** 5.4.1 Where necessary, medical devices and IVD medical devices should be designed to facilitate their safe cleaning, disinfection, sterilization, and re-sterilization by the user, as appropriate. 5.4.2 Medical devices and IVD medical devices labeled as having a specific microbial state should be designed, manufactured and packaged to ensure that they remain in that state when placed on the market and remain so under the transport and storage conditions specified by the manufacturer. 5.4.3 Medical devices and IVD medical devices, delivered in a sterile state should be designed, manufactured and packaged in accordance with appropriate procedures, to ensure that they are sterile when placed on the market and that, unless the packaging which is intended to maintain their sterile condition is damaged, they remain sterile, under the transport and storage conditions specified by the manufacturer, until that packaging is opened at the point of use. It should be ensured that the integrity of that packaging is clearly evident to the final user (for example, through the use of tamper-proof packaging). 5.4.4 Medical devices and IVD medical devices labelled as sterile should be processed, manufactured, packaged, and sterilized by means of appropriate, validated methods. The shelf-life of these medical devices and IVD medical devices should be determined by validated methods. 5.4.5 Medical devices and IVD medical devices intended to be sterilized, either by the manufacturer or user, should be manufactured and packaged in appropriate and controlled conditions and facilities. 5.4.6 Where the medical devices and IVD medical devices are provided non-sterile and are intended to be sterilized prior to use: a) the packaging system should minimize the risk of microbial contamination and should be suitable taking account of the method of sterilization indicated by the manufacturer; and b) the method of sterilization indicated by the manufacturer should be validated. 5.4.7 For medical devices and IVD medical devices placed on the market in both sterile and non-sterile conditions, the label should clearly distinguish between these versions.	Not applicable
5.5	**Considerations of Environment and Conditions of Use** 5.5.1 If the medical device or IVD medical device is intended to be used in combination with other medical devices or IVD medical devices and/or equipment, the whole combination, including the connection system should be safe and should not impair the specified performance of the medical device or IVD medical device. Any known restrictions on use applying to such combinations should be indicated on the label and/or in the	IEC 62366-1 IEC 80001 ISO 80369 (all parts) ISO/IEEE 11073 (all

	instructions for use. Any connections which the user has to handle, such as fluid, gas transfer, electrical or mechanical coupling, should be designed and manufactured in such a way as to remove or appropriately reduce all possible risks, including incorrect connections or safety hazards. 5.5.2 Medical devices and IVD medical devices should be designed and manufactured in consideration of the intended environment and conditions of use, and in such a way as to remove or appropriately reduce the: a) risks of injury to the users or other persons in connection with its physical and ergonomic/usability features; b) risks of user error due to the design of the medical device or IVD medical device user interface, ergonomic/usability features, and the environment in which the medical device or IVD medical device is intended to be used; c) risks connected with reasonably foreseeable external influences or environmental conditions, such as magnetic fields, external electrical and electromagnetic effects, electrostatic discharge, radiation associated with diagnostic or therapeutic procedures, pressure, humidity, temperature, and/or variations in pressure and acceleration; d) risks associated with the use of the medical device or IVD medical device when it comes into contact with materials, liquids, and substances, including gases, to which it is exposed during intended conditions of use; e) risks associated with the possible negative interaction between software and the information technology (IT) environment within which it operates and interacts; f) environmental risks from unexpected egress of substances from the medical device or IVD medical device during use, taking into account the medical device or IVD medical device and the nature of the environment in which it is intended to be used; g) the risk of incorrect identification of specimens/samples/data and the risk of erroneous results due to, for example, confusing color and/or numeric coding on specimen receptacles, removable parts and/or accessories used to perform the analysis, test, or assay as intended; and h) the risks of interference with other medical devices or IVD medical devices normally used in diagnosis, monitoring or treatment. 5.5.3 Medical devices and IVD medical devices should be designed and manufactured in such a way as to remove or appropriately reduce the risks of fire or explosion during normal use and in single fault condition. Particular attention should be paid to medical devices and IVD medical devices whose intended use includes exposure to or in association with flammable or explosive	parts) ASTM F2761 ISO 14971 ISO 5356 (all parts) ISO 21969 ISO 9170 ISO 11197 ISO 7396 (all parts) ISO 10524 (all parts)

	substances or substances which could cause combustion. 5.5.4 Medical devices and IVD medical devices should be designed and manufactured in such a way that adjustment, calibration, and maintenance can be done safely and effectively. Specifically, a) When maintenance is not possible, for example, with implants, the risks from ageing of materials, etc. should be appropriately reduced. b) When adjustment and calibration are not possible, for example, with certain kinds of thermometers, the risks from loss of accuracy of any measuring or control mechanism are appropriately reduced. 5.5.5 Medical devices and IVD medical devices that are intended to be operated together with other medical devices or IVD medical devices or products should be designed and manufactured in such a way that the interoperability and compatibility are reliable and safe. 5.5.6 Medical devices and IVD medical devices should be designed and manufactured in such a way as to appropriately reduce the risk of unauthorized access that could hamper the device from functioning as intended or impose a safety concern. 5.5.7 Any measurement, monitoring or display scale functions of medical devices and IVD medical devices should be designed and manufactured in line with ergonomic/usability principles, taking account of the intended purpose, users and the environmental conditions in which the medical devices and IVD medical devices are intended to be used. 5.5.8 Medical devices and IVD medical devices should be designed and manufactured in such a way as to facilitate their safe disposal or recycling and the safe disposal or recycling of related waste substances by the user, patient or other person. The instructions for use should identify safe disposal or recycling procedures and measures.	
5.6	**Protection against Electrical, Mechanical, and Thermal Risks** 5.6.1 Medical devices and IVD medical devices should be designed and manufactured in such a way as to protect users against mechanical risks connected with, for example, resistance to movement, instability, and moving parts. 5.6.2 Medical devices and IVD medical devices should be designed and manufactured in such a way as to appropriately reduce the risks arising from vibration generated by the medical devices or IVD medical devices, taking account of technical progress and of the means available for limiting vibrations, particularly at source, unless the vibrations are part of the specified performance. 5.6.3 Medical devices and IVD medical devices should be designed and manufactured in such a way as to appropriately reduce the risks arising from the noise emitted, taking account of technical progress and of the means available to reduce noise,	IEC 61010 ISO 14971 ISO 80369 (all parts) ISO 5356 (all parts) IEC 62366-1 ISO 5359 ISO 21969 ISO 7396 (all

	particularly at source, unless the noise emitted is part of the specified performance. 5.6.4 Medical devices and IVD medical devices should be designed and manufactured in such a way as to appropriately reduce the risk related to the failure of any parts within the device that are intended to be connected or reconnected before or during use. 5.6.5 Accessible parts of medical devices and IVD medical devices (excluding the parts or areas intended to supply heat or reach given temperatures) and their surroundings should not attain potentially dangerous temperatures under normal use.	parts) ISO 10524 (all parts)
5.7	**Active Medical Devices and IVD Medical Devices and Medical Devices Connected to Them** 5.7.1 For active medical devices and IVD medical devices, in the event of a single fault condition, appropriate means should be adopted to eliminate or appropriately reduce consequent risks. 5.7.2 Medical devices and IVD medical devices where the safety of the patient depends on an internal power supply should be equipped with a means of determining the state of the power supply and an appropriate warning or indication for when the capacity of the power supply becomes critical. 5.7.3 Medical devices and IVD medical devices where the safety of the patient depends on an external power supply should include an alarm system to signal any power failure. 5.7.4 Medical devices and IVD medical devices intended to monitor one or more clinical parameters of a patient should be equipped with appropriate alarm systems to alert the user of situations which could lead to death or severe deterioration of the patient's state of health. 5.7.5 Medical devices and IVD medical devices should be designed and manufactured in such a way as to appropriately reduce the risks of creating electromagnetic interference which could impair the operation of any devices or equipment in the intended environment. 5.7.6 Medical devices and IVD medical devices should be designed and manufactured in such a way as to provide a level of intrinsic immunity to electromagnetic interference such that is adequate to enable them to operate as intended. 5.7.7 Medical devices and IVD medical devices should be designed and manufactured in such a way as to appropriately reduce the risk of accidental electric shocks to the user or any other person, both during normal use of the medical device or IVD medical device and in the event of a single fault condition in the medical device or IVD medical device, provided the medical device or IVD medical device is installed and maintained as indicated by the manufacturer.	ISO 14971 ISO 18777 (all parts) ISO 11195 ISO 10079-1 ISO 8835-7 ISO 19211

5.8	**Medical Devices and IVD Medical Devices that Incorporate Software or are Software as a Medical Device** 5.8.1 Medical devices and IVD medical devices that incorporate electronic programmable systems, including software, or are software as a medical device, should be designed to ensure accuracy, reliability, precision, safety, and performance in line with their intended use. In the event of a single fault condition, appropriate means should be adopted to eliminate or appropriately reduce consequent risks or impairment of performance. 5.8.2 For medical devices and IVD medical devices that incorporate software or are software as a medical device, the software should be developed, manufactured and maintained in accordance with the state of the art taking into account the principles of development life cycle (e.g., rapid development cycles, frequent changes, the cumulative effect of changes), risk management (e.g., changes to system, environment, and data), including information security (e.g., safely implement updates), verification and validation (e.g., change management process). 5.8.3 Software that is intended to be used in combination with mobile computing platforms should be designed and developed taking into account the platform itself (e.g. size and contrast ratio of the screen, connectivity, memory, etc.) and the external factors related to their use (varying environment as regards level of light or noise). 5.8.4 Manufacturers should set out minimum requirements concerning hardware, IT networks characteristics and IT security measures, including protection against unauthorized access, necessary to run the software as intended. 5.8.5 The medical device and IVD medical device should be designed, manufactured and maintained in such a way as to provide an adequate level of cybersecurity against attempts to gain unauthorized access.	Not applicable
5.9	**Medical Devices and IVD Medical Devices with a Diagnostic or Measuring Function** 5.9.1 Medical devices and IVD medical devices with a diagnostic or measuring (including monitoring) function should be designed and manufactured in such a way as to provide, among other performance characteristics, sufficient accuracy, precision and stability for their intended purpose, based on appropriate scientific and technical methods. a) Where applicable, the limits of accuracy should be indicated by the manufacturer. b) Whenever possible, values expressed numerically should be in commonly accepted, standardized units, and understood by users of the medical device or IVD medical device. While generally supporting the convergence on the global use of internationally standardized measurement units, considerations of safety, user familiarity and established clinical practice may justify the use of other recognized measurement units.	IEC 62366-1 ISO/IEEE 11073 (all parts) ISO 80000-1 ISO 15002 ISO 21360 (all parts)

	c) The function of the controls and indicators should be clearly specified on the medical device and IVD medical device. Where a medical device or IVD medical device bears instructions required for its operation or indicates operating or adjustment parameters by means of a visual system, such information should be understandable to the user and, as appropriate, the patient.	
5.10	**Labeling** The following principle is a general recommendation for labeling. For additional guidance on the contents of the labeling, please refer to IMDRF/GRRP WG/N52. 5.10.1 Medical devices and IVD medical devices should be accompanied by the information needed to distinctively identify the medical device or IVD medical device and its manufacturer. Each medical device and IVD medical device should also be accompanied by, or direct the user to any safety and performance information relevant to the user, or any other person, as appropriate. Such information may appear on the medical device or IVD medical device itself, on the packaging or in the instructions for use, or be readily accessible through electronic means (such as a website), and should be easily understood by the intended user.	ISO 15223-1 ISO 32 ISO 20417 ISO 7396 (all parts) ISO 10524 (all parts)
5.11	**Protection against Radiation** 5.11.1 Medical devices and IVD medical devices should be designed, manufactured and packaged in such a way that exposure of users, other persons, or where appropriate, patients, to radiation is appropriately reduced in a manner that is compatible with the intended purpose, whilst not restricting the application of appropriate specified levels for diagnostic and therapeutic purposes. 5.11.2 The operating instructions for medical devices and IVD medical devices emitting hazardous or potentially hazardous radiation should contain detailed information as to the nature of the emitted radiation, the means of protecting the users, other persons, or where appropriate, patients, and ways of avoiding misuse and of appropriately reducing the risks inherent to transport, storage and installation. 5.11.3 Where medical devices and IVD medical devices are intended to emit hazardous, or potentially hazardous, radiation, they should be fitted, where possible, with visual displays and/or audible warnings of such emissions. 5.11.4 Medical devices and IVD medical devices should be designed and manufactured in such a way that that the exposure of users, other persons, or where appropriate, patients, to the emission of unintended, stray or scattered radiation is appropriately reduced. Where possible and appropriate, methods should be selected which reduce the exposure to radiation of users, other persons, or where appropriate, patients, who may be affected. 5.11.5 For medical devices and IVD medical devices emitting	Not applicable

	hazardous or potentially hazardous radiation and that require installation, information regarding the acceptance and performance testing, the acceptance criteria, and the maintenance procedure should be specified in the operating instructions. 5.11.6 Where medical devices and IVD medical devices are intended to emit hazardous, or potentially hazardous, radiation, accessible to user, they should be designed and manufactured in such a way as to ensure that the quantity, geometry, energy distribution (or quality), and other key characteristics of the radiation emitted can be appropriately controlled and adjusted and, where appropriate, monitored during use. Such medical devices and IVD medical devices should be designed and manufactured to ensure reproducibility of relevant variable parameters within an acceptable tolerance.	
5.12	**Protection against the Risks posed by Medical Devices and IVD Medical Devices intended by the Manufacturer for use by Lay Users** 5.12.1 Medical devices and IVD medical devices for use by lay users (such as self-testing or near-patient testing intended for use by lay users) should be designed and manufactured in such a way that they perform appropriately for their intended use/purpose taking into account the skills and the means available to lay users and the influence resulting from variation that can be reasonably anticipated in the lay user's technique and environment. The information and instructions provided by the manufacturer should be easy for the lay user to understand and apply when using the medical device or IVD medical device and interpreting the results. 5.12.2 Medical devices and IVD medical devices for use by lay users (such as self-testing or near-patient testing intended for use by lay users) should be designed and manufactured in such a way as to: a) ensure that the medical device and IVD medical device can be used safely and accurately by the intended user per instructions for use. When the risks associated with the instructions for use cannot be mitigated to appropriate levels, these risks may be mitigated through training. b) appropriately reduce the risk of error by the intended user in the handling of the medical device or IVD medical device and, if applicable, in the interpretation of the results. 5.12.3 Medical devices and IVD medical devices for use by lay users (such as self-testing or near-patient testing intended for use by lay users) should, where appropriate, include means by which the lay user: a) can verify that, at the time of use, the medical device or IVD medical device will perform as intended by the manufacturer, and b) is warned if the medical device or IVD medical device has failed to operate as intended or to provide a valid result.	IEC 62366-1
5.13	**Medical Devices and IVD Medical Devices Incorporating**	

	Materials of Biological Origin 5.13.1 For medical devices and IVD medical devices that include tissues, cells, or substances of animal, plant, or bacterial origin or their derivatives, which are non-viable or rendered non-viable the following should apply: a) where appropriate, taking into account the animal species, tissues and cells of animal origin, or their derivatives, should originate from animals that have been subjected to veterinary controls that are adapted to the intended use of the tissues. Information on the geographical origin of the animals may need to be retained by manufacturers depending on jurisdictional requirements. b) sourcing, processing, preservation, testing and handling of tissues, cells and substances of animal origin, or their derivatives, should be carried out so as to provide safety for patients, users and, where applicable, other persons. In particular, safety with regards to viruses and other transmissible agents should be addressed by implementation of validated state of the art methods of elimination or inactivation in the course of the manufacturing process, except when the use of such methods would lead to unacceptable degradation compromising the medical device or IVD medical device. 5.13.2 For Regulatory Authorities, which regulate products manufactured utilizing tissues, cells, or substances of human origin or their derivatives as medical devices or IVD medical devices, the following should apply: a) donation, procurement and testing of the tissues and cells should be done in accordance with jurisdictional requirements; and b) processing, preservation and any other handling of those tissues and cells or their derivatives should be carried out so as to provide safety for patients, users and, where applicable, other persons. In particular, safety with regard to viruses and other transmissible agents should be addressed by appropriate methods of sourcing and by implementation of validated state of the art methods of elimination or inactivation in the course of the manufacturing process. 5.13.3 For medical devices and IVD medical devices manufactured utilizing biological substances other than those referred to in Sections 5.13.1 and 5.13.2 (for example, materials of plant or bacterial origin), the processing, preservation, testing and handling of those substances should be carried out so as to provide safety for patients, users and, where applicable, other persons, including in the waste disposal chain. In particular, safety with regards to viruses and other transmissible agents should be addressed by appropriate methods of sourcing and by implementation of validated state of the art methods of elimination or inactivation in the course of the manufacturing process. Other requirements can apply in specific regulatory jurisdictions.	Not applicable

6.0 Essential Principles Applicable to Medical Devices other than IVD Medical Devices		
6.1	**Chemical, Physical and Biological Properties** 6.1.1 With regards to chemical, physical, and biological properties of a medical device, particular attention should be paid to the compatibility between the materials and substances used and biological tissues, cells and body fluids, taking account of the intended purpose of the device and, where relevant (for example, for some absorbable products), absorption, distribution, metabolism and excretion. 6.1.2 Medical devices should be designed and manufactured in such a way that they can be used safely with the materials, substances, and gases, with which they enter into contact during their intended use; if the devices are intended to administer medicinal products they should be designed and manufactured in such a way as to be compatible with the medicinal products concerned in accordance with the provisions and restrictions governing those medicinal products and that the performance of both the medicinal products and of the devices is maintained in accordance with their respective indications and intended use. 6.1.3 Medical devices should be designed and manufactured in such a way as to appropriately reduce the risks linked to the size and the properties of particles which are or can be released into the patient's or user's body, unless they come into contact with intact skin only. Special attention should be given to nanomaterials.	ISO 10993-1 and relevant parts ISO 14971 ISO 18562 (all parts) ISO 7396-1 ISO 21969 ISO 23328-1 ISO 23328-2 ISO 15001
6.2	**Protection against Radiation** 6.2.1 Medical devices emitting ionizing radiation intended for medical imaging should be designed and manufactured in such a way as to achieve an image and/or output quality that are appropriate to the intended medical purpose whilst minimizing radiation exposure of the patient, user, and other persons. 6.2.2 Medical devices emitting ionizing radiation should be designed to allow the accurate estimation (or monitoring), display, reporting, and recording of the dose from a treatment.	Not applicable
6.3	**Particular Requirements for Implantable Medical Devices** 6.3.1 Implantable medical devices should be designed and manufactured in such a way as to remove or appropriately reduce the risks associated with medical treatment, e.g. the use of defibrillators, high-frequency surgical equipment. 6.3.2 Active programmable implantable medical devices should be designed and manufactured in a manner that allows the unequivocal identification of the device without the need for a surgical operation.	Not applicable
6.4	**Protection against the Risks Posed to the Patient or User by Medical Devices Supplying Energy or Substances** 6.4.1 Medical devices for supplying the patient with energy or	ISO 7396 (all parts)

	substances should be designed and manufactured in such a way that the amount to be delivered can be set and maintained accurately enough to ensure the safety of the patient, user, and others. 6.4.2 Medical devices should be fitted with the means of preventing and/or indicating any inadequacies in the amount of energy delivered or substances delivered which could pose a danger. Devices should incorporate suitable means to appropriately reduce the risk of accidental release of dangerous levels of energy or substances from an energy and/or substance source.	ISO 10524 (all parts)
6.5	**Medical Devices Incorporating a Substance Considered to be a Medicinal Product/Drug** 6.5.1 Where a medical device incorporates, as an integral part, a substance which, if used separately may be considered to be a medicinal product/drug as defined in the relevant legislation that applies in that Regulatory Authority and which is liable to act upon the body with action ancillary to that of the medical device, the safety and performance of the medical device as a whole should be verified, as well as the identity, safety, quality and efficacy of the substance in the specific combination product.	ISO 7396 (all parts)
7.0 Essential Principles Applicable to IVD Medical Devices		
7.1	**Chemical, Physical and Biological Properties** 7.1.1 With regards to chemical, physical, and biological properties for IVD medical devices, attention should be paid to the possibility of impairment of analytical performance due to physical and/or chemical incompatibility between the materials used and the specimens, analyte or marker to be detected and measured (such as biological tissues, cells, body fluids and micro-organisms), taking account of the intended purpose of the device.	Not applicable
7.2	**Performance Characteristics** 7.2.1 IVD medical devices should achieve the analytical and clinical performances, as stated by the manufacturer that are applicable to the intended use/purpose, taking into account the intended patient population, the intended user, and the setting of intended use. These performance characteristics should be established using suitable, validated, state of the art methods. For example: a) The analytical performance can include, but is not limited to, • Traceability of calibrators and controls • Accuracy of measurement (trueness and precision) • Analytical sensitivity/Limit of detection • Analytical specificity • Measuring interval/range • Specimen stability b) The clinical performance, for example diagnostic/clinical sensitivity, diagnostic/clinical specificity, positive predictive value, negative predictive value, likelihood ratios, and expected values in normal and affected populations.	Not applicable

	c) Validated control procedures to assure the user that the IVD medical device is performing as intended, and therefore the results are suitable for the intended use. 7.2.2 Where the performance of an IVD medical device depends on the use of calibrators or control materials, the traceability of values assigned to such calibrators or control materials should be ensured through available reference measurement procedures or available reference materials of a higher order. 7.2.3 Wherever possible, values expressed numerically should be in commonly accepted, standardized units and understood by the users of the IVD medical device. 7.2.4 The performance characteristics of the IVD medical device should be evaluated according to the intended use statement which may include the following: a) intended user, for example, lay user, laboratory professional; b) intended use environment, for example, patient home, emergency units, ambulances, healthcare centers, laboratory; c) relevant populations, for example, pediatric, adult, pregnant women, individuals with signs and symptoms of a specific disease, patients undergoing differential diagnosis, blood donors, etc. Populations evaluated should represent, where appropriate, ethnically, gender, and genetically diverse populations so as to be representative of the population(s) where the device is intended to be marketed. For infectious diseases, it is recommended that the populations selected have similar prevalence rates.	

Annex B

Reference Standards for MGS

This annex lists the medical devices and components of a medical gas system.

Note. For undated references, the latest edition of the referenced documents/standards (including any amendments) applies.

No.	Medical gas system	Reference Standards
1	Gas in cylinders, cylinder bundles or high-pressure reservoir(s)	ISO 32, ISO 10961
2	Non-cryogenic liquid in cylinders	ISO 7396 (all parts)
3	Cryogenic or non-cryogenic liquid in mobile vessels	ISO 7396 (all parts), ISO 5359
4	Cryogenic or non-cryogenic liquid in stationary vessels	ISO 7396 (all parts), ISO 5359
5	Air compressor unit (medical air 4 Bar and surgical air 7 Bar)	ISO 7396 (all parts)
6	Proportioning unit	ISO 7396 (all parts)
7	Oxygen concentrator unit.	ISO 7396 (all parts)
8	Vacuum pump;	ISO 21360 (all parts)
9	Pressure gauges;	ISO 10524 (all parts)
10	Pressure relief equipment;	ISO 10524 (all parts)
11	Pressure Regulator/Valves;	ISO 10524 (all parts)
12	Sensing devices;	ISO 10524 (all parts)
13	Monitoring and alarm system (emergency operating alarms, emergency clinical alarm, operating alarm and information signal)	IEC 60601-1-8
14	Manifold	ISO 10524 (all parts)
15	Pipes	ISO 7396 (all parts)
16	Hose Assemblies/ Flexible connection	ISO 5359
17	Shut-off valves	ISO 19211
18	Terminal units	ISO 9170
19	Medical supply units (e.g. ceiling pendants, bedhead units, booms)	ISO 11197
20	Transportable liquid oxygen systems	ISO 18777 (all parts)
21	Gas mixers	ISO 11195
22	Gas-specific connectors	ISO 80369 (all parts)
23	Flow-metering devices	ISO 15002

Bibliography

[1] *ISO 10079-1, Medical suction equipment — Part 1: Electrically powered suction equipment*

[2] *ISO 10524 (all parts), Pressure regulators for use with medical gases*

[3] *ISO 10961, Gas cylinders — Cylinder bundles — Design, manufacture, testing and inspection*

[4] *ISO 10993 (all parts), Biological evaluation of medical devices*

[5] *ISO 11195, Gas mixers for medical use — Stand-alone gas mixers*

[6] *ISO 11197, Medical supply units*

[7] *ISO 12500, Filters for compressed air — Test methods*

[8] *ISO 13485, Medical devices — Quality management systems — Requirements for regulatory purposes*

[9] *ISO 14155, Clinical investigation of medical devices for human subjects — Good clinical practice*

[10] *ISO 14971, Medical devices — Application of risk management to medical devices*

[11] *ISO 15001, Anaesthetic and respiratory equipment — Compatibility with oxygen*

[12] *ISO 15002, Flow-metering devices for connection to terminal units of medical gas pipeline systems*

[13] *ISO 15223-1, Medical devices — Symbols to be used with information to be supplied by the manufacturer — Part 1: General requirements*

[14] *ISO 18562 (all parts), Biocompatibility evaluation of breathing gas pathways in healthcare applications*

[15] *ISO 18777 (all parts), Transportable liquid oxygen systems for medical use — Particular requirements*

[16] *ISO 19211, Anaesthetic and respiratory equipment — Fire-activated oxygen shut-off devices for use during oxygen therapy*

[17] *ISO 20417 - Medical devices — Information to be supplied by the manufacturer*

[18] *ISO 21360 (all parts), Vacuum technology — Standard methods for measuring vacuum-pump performance*

[19] *ISO 21969, High-pressure flexible connections for use with medical gas systems*

[20] *ISO 23328-1, Breathing system filters for anaesthetic and respiratory use — Part 1: Salt test method to assess filtration performance*

[21] *ISO 23328-2, Breathing system filters for anaesthetic and respiratory use — Part 2: Non-filtration aspects*

[22] *ISO 32, Gas cylinders for medical use — Marking for identification of content*

[23] *ISO 4135, Anaesthetic and respiratory equipment — Vocabulary*

[24] *ISO 5356 (all parts), Anaesthetic and respiratory equipment — Conical connectors*

[25] *ISO 5359, Anaesthetic and respiratory equipment — Low-pressure hose assemblies for use with medical gases*

[26] *ISO 7396 (all parts), Medical gas pipeline systems*

[27] *ISO 80000-1, Quantities and units — Part 1: General*

[28] *ISO 80369 (all parts), Small-bore connectors for liquids and gases in healthcare applications*

[29] *ISO 8835-7, Inhalational anaesthesia systems — Part 7: Anaesthetic systems for use in areas with limited logistical supplies of electricity and anaesthetic gases*

[30] *ISO 9170 (all parts), Terminal units for medical gas pipeline systems*
[31] *ISO/IEEE 11073 (all parts), Health informatics*
[32] *IEC 60601-1-8, Medical electrical equipment - Part 1-8: General requirements for basic safety and essential performance - Collateral Standard: General requirements, tests and guidance for alarm systems in medical electrical equipment and medical electrical systems*
[33] *IEC 60812, Failure modes and effects analysis (FMEA and FMECA)*
[34] *IEC 61010, Safety requirements for electrical equipment for measurement, control, and laboratory use*
[35] *IEC 62366-1, Medical devices — Part 1: Application of usability engineering to medical devices*
[36] *IEC 80001, Application of risk management for IT-networks incorporating medical devices*
[37] *ASTM F2761, Medical Devices and Medical Systems - Essential safety requirements for equipment comprising the patient-centric integrated clinical environment (ICE) Part 1: General requirements and conceptual model*

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