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**Information technology — Evaluation  
methodology for environmental  
influence in biometric system  
performance**

*Technologies de l'information — Méthodologie de l'évaluation de  
l'influence environnementale dans la performance d'un système  
biométrique*



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## Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: [Foreword — Supplementary information](#).

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, SC 37, *Biometrics*.

## Introduction

The performance of biometric systems can vary according to environmental conditions (see e.g. ISO/IEC 19795-1:2006, C.2.6, ISO/IEC TR 19795-3:2007, Table 4). Environmental conditions can affect subjects' ease of use and comfort in using the systems, subjects' biometric characteristics, and also the devices used for acquisition of biometric samples.

This International Standard provides a generic methodology to analyse the influence of environmental conditions on biometric system performance.

**NOTE** Environmental conditions can affect several elements involved in the recognition process. However, the proposed evaluation methodology does not distinguish which of them is affected. The intention of this methodology is to quantify the overall influence analysing the biometric system performance.

For this International Standard, environmental conditions has to be understood as all atmospheric parameters (e.g. temperature, humidity) and other physical and chemical phenomena (e.g. illumination, noise) that can surround the biometric system and influence in its performance. Certain environmental conditions such as vibration are not dealt with in this International Standard.

These evaluations consist of carrying out a similar “end-to-end” biometric performance evaluation in one or more predefined environments. These environments can be real (naturally occurring) or modelled (artificially controlled).

There are two possible ways to carry out an “end-to-end” biometric performance evaluation: performing scenario evaluations or operational evaluations. In scenario evaluations, biometric systems are assessed in modelled environments considering a real-world target application and population. These evaluations are specified as a special case of scenario test based on ISO/IEC 19795-2. An evaluation performed in a controlled environment can be reproducible, unlike in an operational environment which uncontrolled parameters can affect the system. In operational evaluations, biometric systems are analysed in real environments using a target population. These evaluations are specified as a special case of operational evaluations based on ISO/IEC 19795-6. Operational testing can lack the precision of scenario testing (in terms of the levels of the environmental parameters), but the testing will benefit in terms of being operationally realistic. This International Standard provides testing requirements specific to environmental testing for both kinds of evaluations.

The methodology addresses how to test several environmental factors; however, an evaluation that conforms to this International Standard can consider as few as one single environmental parameter. The test parameter or parameters to assess and control has to be previously defined by participants involved in the evaluation.

The targets of this kind of evaluations include:

- Analyse how one or a combination of environmental factors can affect the biometric system performance and quantify this influence.
- Analyse how a biometric system works in a specific controlled environment, compared to the same system working in a reference evaluation environment.
- Analyse how a biometric system behaves in a real environment compared to the same system working in a modelled environment simulating the operational environment.

The results of these evaluations can inform suppliers and users so that they can assess which environmental conditions are likely to affect the performance of a biometric system under conditions they expect to encounter. Results can also indicate whether the particular biometric modality and method of implementation is appropriate for the situation under which the system is expected to be used. Also this methodology can be used for examining environmental parameters under which biometric systems poorly.

# Information technology — Evaluation methodology for environmental influence in biometric system performance

## 1 Scope

This International Standard addresses

- fundamental requirements for planning and execution of environmental performance evaluations for biometric systems based on scenario and operational test methodologies,
- specifications to define, establish, and measure specific conditions to assess, including requirements for equipment,
- requirements for establishing a baseline performance in order to compare the influence of environmental parameters,
- a specification of the biometric evaluation including requirements for test population, test protocols, data to record, and test results, and
- procedures for carrying out the overall evaluation.

This International Standard does not

- determine which parameters should be analysed for a specific biometric modality (This is currently covered in ISO/IEC/TR 19795-3.),
- specify requirements to perform a vulnerability analysis modifying environmental factors (This is covered by ISO/IEC 19792.),
- classify biometric systems upon performance against different environmental conditions, or
- specify requirements for determining the functional effects of environmental conditions on hardware components (such as corrosion, electrical interference, breakage, etc.) of biometric systems.

## 2 Conformance

Environmental tests of biometric systems shall be based on scenario evaluations or operational evaluations. Scenario evaluations shall conform with mandatory requirements of [Clause 7](#) whereas operational evaluations shall conform with mandatory requirements of [Clause 8](#).

Further, a scenario evaluation that conforms to this International Standard shall analyse at least two evaluation conditions: the reference evaluation environment and one target evaluation environment. Both shall consider at least one environmental parameter to assess such as temperature, humidity, illumination, etc. These evaluation conditions shall be selected, specified, measured, and recorded in accordance with [Clause 6](#).

## 3 Normative references

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

ISO/IEC 19795-1:2006, *Information technology — Biometric performance testing and reporting — Part 1: Principles and framework*

ISO/IEC 19795-2, *Information technology — Biometric performance testing and reporting — Part 2: Testing methodologies for technology and scenario evaluation*

ISO/IEC 19795-6, *Information technology — Biometric performance testing and reporting — Part 6: Testing methodologies for operational evaluation*

## 4 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19795-1 and the following apply.

### 4.1 ambient conditions

#### real environment

common, prevailing, and uncontrolled atmospheric and weather conditions in a room or place

Note 1 to entry: A test described as “conducted at ambient conditions” was performed at whatever conditions were prevailing at that time on that day.

### 4.2 baseline performance

performance of a biometric system in a reference evaluation environment

### 4.3 controlled conditions

climatic and physical conditions that are constrained or managed or kept within certain bounds for the testing purpose

### 4.4 environment generator

specialized test equipment used to establish and maintain the controlled conditions of the test

### 4.5 environmental conditions

all atmospheric parameters (e.g. temperature, humidity) and other physical and chemical phenomena (e.g. illumination) that can surround the biometric system and influence in its performance

Note 1 to entry: These can be controlled or ambient.

### 4.6 evaluation condition

environmental condition under which an evaluation is executed

### 4.7 evaluation configuration

physical layout of the environment in which the biometric system is going to be tested including the necessary equipment and test instruments for performing tests

### 4.8 evaluation environment

environment in which the biometric system is evaluated considering the environmental conditions and the evaluation configuration

### 4.9 extreme condition

condition that entails very high or very low values of the environmental parameters and may be hostile for systems operation or even human life



**4.10****instrument**

calibrated equipment used to measure and/or record environmental parameters (such as temperature, humidity, illumination, and sound)

Note 1 to entry: In some cases, instruments have the integrated capability of both measuring and recording parameters in one piece of equipment.

**4.11****measuring point**

specific value for an environmental parameter that is being assessed

**4.12****operational environment**

conditions under which the biometric system is expected to operate

Note 1 to entry: This is a combination of environmental factors and operational procedures.

**4.13****reference evaluation environment**

evaluation environment in which the biometric system is analysed to obtain baseline performance metrics

**4.14****set point**

specific value for an environmental parameter that is being controlled

**4.15****target evaluation environment**

evaluation environment in which the biometric system is analysed to obtain performance metrics for studying the influence of certain environmental conditions

**5 Overview****5.1 Introduction**

An environmental evaluation is a set of trials carried out to analyse the biometric performance of one or more biometric systems working in particular environmental conditions to determine the effect of one or more of the conditions. These may be executed as one of two types of biometric evaluations: scenario evaluations and operational evaluations. Scenario evaluations analyse “end to end” biometric system performance in a modelled environment whereas operational evaluations analyse “end to end” biometric system performance in an uncontrolled operational environment.

Once the biometric evaluation is carried out in each of the different evaluation conditions, a group of performance metrics will be calculated. These metrics are specific for these evaluation conditions.

The number of evaluation conditions to analyse will depend on the following aspects:

- if the evaluation environment is real or modelled and how many variations of environmental parameters are feasible;
- if the objective is analysing the influence of one or more environmental parameters separately and how many measuring points are going to be examined per each parameter;
- if the objective is checking how a biometric system works in a particular environment.

These aspects are not independent. A decision on conducting a scenario or operational evaluation will depend upon the objectives of the environmental evaluation, the number of parameters to assess, and whether the environment is real or modelled. The following subclauses describe both kinds of environmental evaluations and their main characteristics.

## 5.2 Scenario evaluations

Scenario evaluations consist of defining one or more specific evaluation conditions as well as a reference evaluation environment and carrying out a similar scenario test in each of them. In these evaluations, the biometric system and environmental parameters will be recorded at the same time in order to determine error rates and throughput rates for the specific evaluation conditions. This approach provides insights into the degree to which biometric systems are influenced by one or more environmental parameters. A schema of this evaluation methodology is shown in [Figure 1](#).

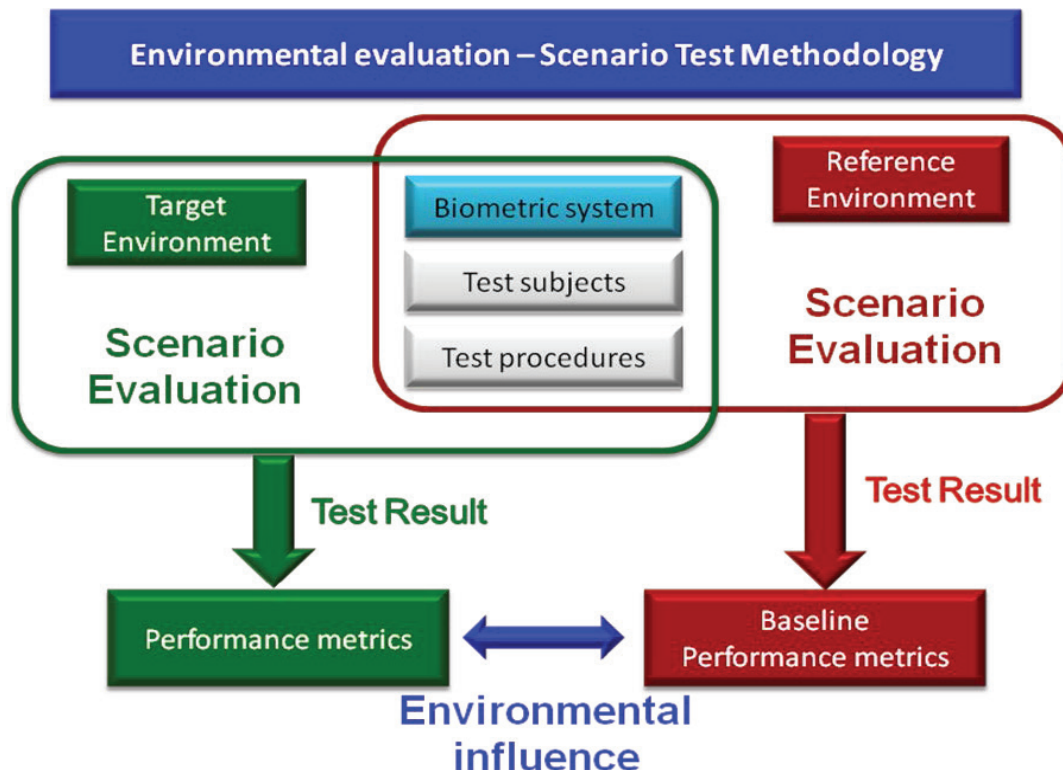


Figure 1 — Scenario Test Methodology illustration

Scenario evaluations are developed in a controlled environment usually in a test facility. These evaluations are suitable for

- measuring the influence of one or more controllable environmental parameters, or
- analysing how one or more biometric systems perform in a specific environment whose parameters are set to defined values or kept inside a particular range.

In both cases, the environmental parameters being assessed, their corresponding measuring points or ranges, and the environmental parameters being controlled shall be determined prior to the test.

## 5.3 Operational evaluations

Operational evaluations consist of determining a specific environment and selecting one or more environmental parameters to assess. In these evaluations, the relevant biometric system performance and the selected environmental parameters to assess will be recorded at the same time. This approach provides insights into the degree to which biometric system performance is influenced by the assessed parameters of the operational environment.

Operational evaluations are carried out in an uncontrolled environment. When performing this type of evaluation, it may be difficult to isolate the impact of environmental parameters on users, algorithms, or equipment; the impact is measured for the system as a whole.

Environmental conditions should reflect those typically encountered when the system is not under evaluation. Thus, an operational test may permit operationally viable practices such as use of a canopy for outdoor collection of facial images. Therefore, for this evaluation, the operational environment including physical layout as well as the environmental parameters that are going to be assessed shall be described.

In addition, it will be necessary that evaluators specify which evaluation conditions are of interest. It will require conducting a preliminary analysis of the operational environment for knowing the potential values of the environmental parameters.

This analysis shall be carried out before planning the operational evaluation in order to determine the following aspects:

- instruments for measuring and recording the environmental parameters to assess;
- the localization of such instruments;
- the definition of the reference evaluation environment.

## 6 Evaluation conditions specification

### 6.1 Introduction

Biometric systems can be tested in different evaluation conditions in order to analyse whether their performance is influenced by environmental conditions or not. This Clause defines requirements for defining and measuring such evaluation conditions for all potential environmental parameters that can be tested during this kind of evaluations.

### 6.2 Definition of evaluation conditions

#### 6.2.1 Description of the evaluation conditions

In general, the evaluation environmental conditions shall be defined considering the following two aspects:

- Environmental parameters to assess: These are the environmental conditions whose influence is going to be studied. Such conditions will be established to a specific value or narrow range denominated measuring point. It is mandatory to specify at least one parameter.
- Environmental parameters to control: These environmental conditions may influence biometric performance but they are not the target of the trial. Such conditions will be established to the same set point specified for the reference evaluation environment. It is optional to specify any control parameter.

#### 6.2.2 Types of environmental parameters

One or more environmental parameters shall be established for the specification of the evaluation. Environmental parameters shall be described using units in the SI system whenever possible.

An environmental evaluation may consider the following types of environmental parameters:

- a) Temperature: This parameter shall be specified using Celsius degrees [°C].
- b) Humidity: This parameter shall be specified by the percentage of relative humidity using [%].
- c) Illuminance: This parameter shall be specified using lux [lx].
- d) Irradiance: This parameter shall be specified using watts per square meter [W/m<sup>2</sup>].
- e) Noise: This parameter shall be specified by the noise level using decibels [dB].

f) Atmospheric pressure: This parameter shall be specified using kilopascals [kPa].

## 6.3 Selection of the evaluation conditions

### 6.3.1 General

The selection of the evaluation conditions entails two activities. Firstly, the parameters to be assessed and/or controlled shall be defined and reported depending on the type of biometric evaluation (e.g. temperature, humidity). This decision is mainly based on the biometric modality of the system under test as well as the type of technology used by its capture sensor. These parameters shall be selected by parties involved in the evaluation.

NOTE ISO/IEC/TR 19795-3<sup>[1]</sup> lists environmental factors that can impact performance on a modality-by-modality basis.

Then, the measuring points and set points shall be specified for the selected environmental parameters to assess and/or control respectively. This specification shall consider two aspects: the types of biometric performance evaluation (i.e. scenario or operational evaluation) and the different phases of the recognition process (i.e. enrolment and verification).

This subclause establishes requirements to select the measuring and set points for both types of environments (i.e. target evaluation environment and reference evaluation environment) considering also the aspects above mentioned.

NOTE Since it is mandatory for scenario test methodology to carry out evaluations to obtain the baseline performance apart from any other evaluation performed in the target evaluation conditions, these values can be specified for the reference evaluation environment and the target evaluation environments.

### 6.3.2 Reference evaluation environment for scenario evaluations

The reference evaluation environment defines the values or ranges for different environmental parameters under which baseline performance data will be obtained in scenario evaluation.

Evaluation conditions for this environment shall be specified for the environmental parameters to be assessed and controlled. The values shall be defined considering the values proposed for a standard environment in [Annex A](#).

If some parameters are dependent, the specification of these parameters shall be according to their dependency.

The laboratory testing environment should reach these reference values without any additional equipment. Therefore, the evaluation configuration is not disturbed by anything and it will be possible to obtain performance results considering only the influence of the environmental parameter under test, apart from the common factors that affect biometric systems.

### 6.3.3 Target evaluation environments

#### 6.3.3.1 General

This Clause describes how to select the evaluation conditions for carrying out enrolment and verification functionalities depending on the type of biometric evaluation and the particular objectives to achieve in the environmental evaluation.

It is recommended that the value or range of environmental factor/factors to be assessed will be relevant to the target environment (modelled or real).

### 6.3.3.2 Enrolment evaluation conditions

This environment shall be the environment in which users are enrolled. For scenario evaluations, this environment shall be selected by parties involved in the evaluation considering the objectives of the environmental testing. There are two possibilities for selecting it:

- similar to the reference evaluation environment, or
- a specific environment.

NOTE 1 If the target evaluation is a scenario evaluation to analyse the influence of one or a combination of environmental parameters, the proper enrolment environment will be an environment similar to the reference evaluation environment.

NOTE 2 If the target evaluation is a scenario evaluation to analyse a specific environment, the enrolment environment can be selected considering both options. The most appropriate enrolment environment will depend on the objectives to achieve with the environmental testing.

NOTE 3 In the case of a scenario evaluation performed to obtain the baseline performance for an operational evaluation, the enrolment environment can be selected similar to the operational environment where the enrolment is going to be carried out.

NOTE 4 If an objective of the evaluation is to determine the influence of specific environmental factors on enrolment rates and/or the quality of enrolments, these parameters can be specified in addition to the reference evaluation environment.

For operational evaluations, this environment shall be the particular environment where enrolment is performed during typical operations.

### 6.3.3.3 Verification evaluation conditions

#### 6.3.3.3.1 General

The verification evaluation environment is the environment in which biometric trials take place. Verification evaluation conditions vary for scenario and operational evaluations.

#### 6.3.3.3.2 Evaluation conditions for scenario evaluations

The evaluation conditions for scenario evaluations depend on three potential objectives.

- a) Quantify the influence of one single parameter. In this case, a set of evaluation conditions shall be determined, each with one or more measuring points. In these evaluation conditions, environmental conditions shall be as follows.
  - The environmental parameter to assess shall be fixed to a defined value or a narrow range.
  - The rest of environmental conditions to control shall be kept inside the range specified in the reference evaluation environment defined for the target evaluation. The range may vary depending on whether the environmental parameters can be isolated and on the testing capabilities of the laboratory. The way to select this reference evaluation environment has been explained in [6.3.2](#).

EXAMPLE 1 If the biometric system under test is a vascular system and the assessed parameter is illumination, the evaluation conditions have only a specific set of measuring points for the illumination parameter. The values of the rest of mandatory parameters to be controlled, such as temperature, relative humidity, or noise are kept inside the range specified in the evaluation for the reference evaluation environment.

The values for the environmental parameter to assess should be:

- Different values covering the biometric system operational range (e.g. one measuring point for the minimum value, another for the maximum value, and two more between the boundaries)

— Extreme conditions.

[Annex A](#) provides guides to select the operational range and extreme conditions values.

- b) Quantify the influence of a combination of parameters. The selection of the measuring points is similar to objective (1), with the additional condition that the experimenter shall identify dependencies between parameters being assessed.
- c) Analyse how the biometric system or systems work in a specific environment. In this case, the environmental parameters of the evaluation conditions shall be fixed to the corresponding value or range specified for such environment.

EXAMPLE 2 If the biometric system under test is a vascular system and it is necessary to know its performance for a temperature of 35 °C, a relative humidity from 40 % to 60 % and noise level of 50 dB, the environmental parameter values of the evaluation conditions will be precisely maintained at a temperature of 35 °C, relative humidity from 40 % to 60 % and noise level of 50 dB.

#### 6.3.3.3.3 Evaluation conditions for operational evaluations

The evaluation conditions for operational evaluations are determined by the operational environment in which the biometric system or systems are going to work. The environmental parameters to be assessed shall be identified and their expected operational ranges shall be specified. However, it is not necessary to specify their measuring points because these values shall be recorded but not controlled.

If the objective of the evaluation is to study a specific operational environmental condition, values or ranges for relevant environmental parameters shall be specified. Such ranges and values shall be within those potentially encountered in the operational environment.

### 6.4 Measurement and recording of the environmental conditions

#### 6.4.1 General

In order to analyse the environmental influence in performance results, the selected environmental parameters shall be measured and recorded during the biometric trials. Instruments and requirements to perform this task shall be specified.

NOTE [Annex B](#) contains additional information about measuring and recording instruments as well as examples considering environmental parameters such as temperature, humidity, and illumination.

#### 6.4.2 Instruments to measure and record environmental conditions

The equipment for measuring the environment shall meet the following requirements:

- instruments shall be able to measure the maximum and minimum value of the measuring points to be assessed,
- the resolution of the instruments shall be appropriate for recording changes, and
- instruments shall be calibrated previously.

NOTE In many situations these instruments can be integrated into generation and control devices (e.g. climatic chamber).

#### 6.4.3 Requirements for measuring and recording environmental conditions

The environmental parameters to be measured and recorded during the test of one evaluation environment will be the specific parameters selected for it. These parameters shall be recorded at the same time as the biometric attempt. When the sensor and point of capture are not collocated, parameters shall be measured at all relevant points, potentially including at the point of sample acquisition and at the sensor.



There are two ways to record these parameters. On one hand, the outcome of the biometric system comparison can be recorded together with the value of the environmental parameters. On the other hand, the outcome of the biometric system and environmental parameters can be recorded separately but both shall have a date-time stamp to be able to associate it.

## 7 Biometric scenario evaluation

### 7.1 Introduction

This clause specifies a general scenario covering all requirements for executing biometric performance evaluations. This scenario is based on ISO/IEC 19795-1 and ISO/IEC 19795-2 and it has been adapted to analyse the influence of environmental factors.

Biometric scenario evaluations shall be performed following both the requirements specified in this clause and scenario testing requirements specified in ISO/IEC 19795-2.

### 7.2 Define evaluation objectives

The following evaluation objectives shall be defined:

- A description of the biometric system to analyse. This consists of an explanation of the modality the system is based on as well as the components that compose the system to test.
- A guide of how the biometric system works. This guide will be used during the subsequent tests.
- The environmental parameter or parameters to assess as well as the environmental parameter or parameters to control.
- The specification of the reference and target evaluation environments and the specific parameter values for all measuring points and set points.

### 7.3 Environment

#### 7.3.1 Environment for enrolment

Enrolment always shall be carried out in the enrolment environment. This shall be selected in accordance to [6.3.3.2](#).

#### 7.3.2 Generation and control of the environmental conditions

##### 7.3.2.1 General

The particular controlled conditions specified for each scenario shall be achieved. Environmental conditions shall be generated specifically for each defined measuring point, which may also include extreme conditions environment. These changes shall be performed in a controlled manner which may require the use of an environment generator.

NOTE [Annex B](#) contains additional information about the environment generators functionality as well as examples considering environmental parameters such as temperature, humidity, and illumination.

##### 7.3.2.2 Environment generators to generate and control environmental conditions

The environment generators for generating the corresponding environmental parameters shall meet the following requirements.

- Environment generators should be capable of exceeding maximum and minimum values for evaluation conditions. It is recommended to exceed it in order to avoid nonlinear conditions near limits.

- The resolution of the environment generators shall be sufficient to obtain environmental condition values.
- Environment generators shall be calibrated previously.
- In the case that environmental conditions are generated inside the environment generator, this environment generator shall have enough space to introduce a biometric sensor and the user's biometric characteristic.

NOTE In many situations these environment generators can integrate measuring and/or recording instruments (e.g. climatic chamber).

### 7.3.2.3 Requirements to ensure that the environmental conditions have been achieved

The particular requirements of measuring and set points will be achieved if the corresponding parameters are stable. Criteria to determine this stage per parameter shall be specified and reported.

NOTE 1 The time to achieve the environmental conditions stabilization depends upon environmental parameters and the environmental generators used.

NOTE 2 An example of "criteria" can be "No change or within the defined parameter range for at least 30 seconds".

During the evaluation, test subject interaction with the biometric system may coincide with changes in environmental conditions. If these conditions exceed the specified value or range, evaluators shall wait until the measuring and set points will be achieved and are stable again. In addition, if test subjects need to be acclimatized, the specific actions to achieve test subjects acclimatization shall be carried out before continuing with the evaluation.

NOTE 3 Acclimatization requirements are established in [7.5](#).

NOTE 4 It is important to consider the time that takes this process when planning the evaluation. This time can increase the duration of tests and, as a consequence, it might cause tiredness and a lack of motivation of test subjects.

It is recommended to gradually introduce the biometric system to the environmental condition before generating the measuring points because some factors as temperature can damage the biometric system if they are modified too quickly.

### 7.3.3 Biometric system placement

The biometric system under evaluation should be located in the specified evaluation configuration in a manner that allows user interaction as per the biometric system supplier's recommendations. If it is not possible to meet the recommendation of the biometric system supplier, placement shall be by agreement between the testing and the commissioning organizations, identifying any potential influences on performance due to the alternative placement.

## 7.4 Test population

### 7.4.1 General

A wide set of users shall be chosen to participate in performance evaluation. The test crew shall be specific and representative of the targeted user population. Factors like gender, age, ethnic origin, and occupation shall be taken into account.

### 7.4.2 Size

The size of the test crew shall be established collaboratively by the commissioning organization and the testing organization, based on the constraints of cost, time, complexity of the experiments, availability of



the resources, and the required statistical confidence levels. The intended crew size will be documented along with the rationale used to determine the crew size value.

NOTE 1 The number of test subjects that are going to take part in the evaluation can be calculated taking into account the rule of three or the rule of 30 defined in ISO/IEC 19795-1.

NOTE 2 After applying one of these rules, evaluators will obtain the following data:

- Number of test subjects to recruit. This number can be increased around 10 % to allow for subjects leaving the evaluation before it has finished.
- Number of genuine and impostor transactions to execute per test subject to achieve a significant number of comparisons.
- Number of genuine and impostor transactions to execute per test subject per environmental variable measuring point to achieve a significant number of comparisons.

Since each test subject executes genuine and impostor tests under each environmental condition, tests may be time-consuming. Test duration shall be taken into consideration when determining test size.

### **7.4.3 Selection**

Test subjects shall be selected randomly so long as the overall test crew composition requirements (such as age, gender, or other attributes) are met. Subjects shall not have been involved previously during the biometric system implementation or during the algorithm training/tuning process.

### **7.4.4 Training and guidance of test subjects**

#### **7.4.4.1 Test information**

Test subjects shall receive relevant information about the evaluation: objectives, number of visits, and legal issues related to their participation in the evaluation.

NOTE It is important that they know and accept a visit schedule and all related legal issues in order to avoid problems while evaluation is performed.

#### **7.4.4.2 Test instructions**

An explanation of evaluation phases (enrolment and verification) and what test subjects shall do in each of these phases shall be provided to them. If there are some instructions that test subjects shall follow according to the environmental conditions, they have also to be explained.

NOTE Users can know how to use the biometric acquisition sensor within the environment generators to make their interactions easier.

#### **7.4.4.3 Training**

Test subjects shall perform practical trials. Test operators shall supervise these trials and correct mistakes as necessary until each subject demonstrates proficiency in their interactions with the biometric system.

#### **7.4.4.4 Guidance**

During the training and the enrolment process test subjects shall be guided, but during the verification process, test operators will only check that test subjects interact correctly with the biometric system.

#### **7.4.4.5 Feedback**

If the biometric system shows information related to the capture of the biometric sample and the result of matching per each attempt, it shall be made known to test subjects for improving their interactions.

A minimum amount of feedback from the test operator is recommended.

#### **7.4.4.6 Habituated vs. Non-Habituated**

Through training, guidance, and test design, test subjects should be habituated to test devices before conducting enrolment and verification trials. If habituation cannot be achieved, the impact of changing levels of habituation on performance shall be minimized to the extent possible. This may be accomplished by ensuring that all tests utilize habituated and non-habituated users in consistent proportions. Levels of test subject habituation shall be reported.

#### **7.4.5 Visits**

The number of visits shall be more than one. At the first visit test subjects shall perform practice/training trials, then, perform the enrolment process and finally the first session of genuine and impostor transactions. At the subsequent visits, test subjects shall only conduct genuine and impostor transactions.

The number of transactions per subject per visit should be at least 10 genuine transactions and no more than 10 impostor transactions. In addition, all transactions shall be done with disengagement from the device. Test subjects shall execute movements to present their biometric characteristic to the capture sensor in a compliant way to the target application. The intention is to avoid that test subjects present their biometric characteristic to the capture sensor once and keep it positioned there to carry out all attempts and transactions.

### **7.5 Acclimatization**

Depending on the biometric modality and the environmental conditions to assess, a period for acclimatization shall be specified according to the real-world application. Acclimatization refers to the subjects being adapted to the target environmental conditions.

In case this period is necessary, an acclimatization approach shall be defined as part of the test plan. This approach shall include the following:

- times in which this approach shall be carried out,
- minimum duration of the period for acclimatization,
- requirements to achieve the test subject acclimatization, and
- criteria to consider that test subjects are acclimatized.

### **7.6 Levels of effort and decision policies**

Enrolment and verification transaction constraints, including attempts, transactions, and timing, shall be commensurate with the target application. The selected values shall be reported together with test results.

### **7.7 Exception handling protocols**

During the evaluation, different anomalies can happen. Test operators shall take action to ensure that anomalies do not affect evaluation results. The following actions shall be taken for different types of anomalies:

- Biometric system anomalies: These anomalies happen when the biometric sensor does not work correctly. In this case, the test operator shall stop the evaluation and solve the problem. Once the biometric system works well again, the evaluation can continue. Anomalies and its solution shall be reported.
- Environmental anomalies: If changes to environmental conditions are detected, test operators shall measure the environmental parameters and check if these are inside its specified range. If there are

any parameters outside the range, they shall stop the evaluation and correct the potential problems. Once the evaluation conditions are stable and inside the corresponding range, the evaluation can be resumed. Test operators shall report these anomalies.

- Enrolment and verification anomalies: If test operators detect that the test subject has introduced a wrong identifier, has presented a wrong biometric characteristic, or is using the device in a non-compliant fashion, he shall cancel the attempt, inform the test subject about the anomaly, and repeat the transaction.

## 7.8 Data to record and test results

### 7.8.1 General

Evaluators shall monitor and review data recorded during testing to ensure that evaluation methods are applied properly and that test equipment works correctly. All data recorded during testing shall be saved.

Later, biometric comparison scores are used by evaluators to calculate performance statistics and these will be reported together with non-biometric data (e.g. user data and trial data) and environmental data.

NOTE Any personal data (such as biometric data) needs to be taken and used in accordance with data protection and privacy laws.

### 7.8.2 Requirements for recording data

Environmental conditions measurements, data needed for the calculation of performance metrics and other data which are required to report shall be recorded during the evaluation for each evaluation condition.

NOTE [6.4.3](#) addresses specific requirements for recording environmental conditions.

Enrolment and verification errors possibly caused by environmental factors (e.g. fingerprint verification errors resulting from excessive heat-induced sweating) shall be recorded. These errors shall be considered when assessing system performance and usability.

It is recommended to record time synchronised video recording(s) of interaction of trial users with biometric system(s) preferably using a system capable of video analytics to assist efficient analysis.

It is recommended that information should be collected from test subjects on biometric system usability. This information can be collected in the form of exit surveys, usability information volunteered by the test subjects during testing, or other methods.

### 7.8.3 Requirements for calculating results

#### 7.8.3.1 Baseline Performance

A first baseline performance test shall be conducted under reference environmental conditions and in a conventional configuration (i.e. not configured in an environmental chamber). Results from this first test shall be referred to as the Environment Baseline. A second baseline performance test shall be conducted under reference environmental conditions and in the configuration used to generate and control environmental parameters when the configuration of the biometric system under test is potentially impacted by the presence of the environment generating equipment (e.g. an environmental chamber). Results from this second test shall be referred to as the Configuration Baseline.

#### 7.8.3.2 Configuration effects

Comparison of the Configuration Baseline performance against the Environment Baseline performance shall determine the configuration effects. Since both baselines are established with the same reference

environmental conditions, any changes in biometric performance are attributable only to the change in configuration.

**EXAMPLE** A fingerprint reader is under test for the effects of temperature on matching performance. The reader is installed within an environmental chamber with a “through hole” so that the subject’s hand can enter the chamber and engage the reader. Because of the chamber configuration, the angle of presentation of the fingerprint onto the reader is influenced, and viewing of the fingerprint sensor feedback indicators is impaired. The reader as installed in the chamber is measured to have higher false reject error rates than the same reader in the Environment Baseline.

### 7.8.3.3 Isolating the environmental effects

Results shall be expressed as environment-specific performance relative to Configuration Baseline performance.

**EXAMPLE** The following table represents biometric recognition performance test results from a test of a fingerprint system at 5 temperature measuring points. The performance is expressed as the false non-match rate (FNMR) and false match rate (FMR) at the threshold setting used for the test. The same numbers of genuine attempts were performed at each of the 5 temperatures, ranging from 0 °C to 40 °C. All values are expressed as percentages.

Performance Rate	Environment Baseline	Configuration Baseline	All temps	0 °C	10 °C	20 °C	30 °C	40 °C
FNMR	0,5	1,0	2,4	1,0	1,0	1,0	2,0	7,0
FMR	0,1	0,1	0,070	0,050	0,075	0,100	0,075	0,050

Using this sample data, the “Configuration Effect” is calculated as Configuration Baseline — Environment Baseline:

- FNMR\_Configuration Effect =  $(1,0 - 0,5) = 0,5 \%$
- FMR\_Configuration Effect =  $(0,1 - 0,1) = 0,0 \%$

Using the sample data, the “Temperature Effect — overall” is calculated as All temps — Configuration Baseline:

- FNMR\_Temperature Effect =  $(2,4 - 1,0) = 1,4 \%$
- FMR\_Temperature Effect =  $(0,070 - 0,1) = -0,030 \%$

Using the sample data, the “Temperature Effect at 40 °C” is calculated as 40 °C — Configuration Baseline:

- FNMR\_Temperature Effect at 40 °C =  $(7,0 - 1,0) = 6,0 \%$
- FMR\_Temperature Effect at 40 °C =  $(0,050 - 0,1) = -0,050 \%$

Further conclusions can be reached by examining the data, such as: Performance is not affected by temperatures up to 20 °C.

## 7.8.4 Requirements for reporting results

### 7.8.4.1 Performance metrics

Several rates are normally used to measure biometric system performance. Evaluators shall report the same rates that ISO/IEC 19795-1 and ISO/IEC 19795-2 specified for their evaluation for each evaluation conditions.

Environment Baseline and Configuration Baseline performance shall be reported.

#### 7.8.4.2 Non-biometric data

The following non-biometric data shall be reported along with performance metrics:

- Trial users: The number of users that have participated in each trial and their demographic details.
- Environmental data: Data collected during evaluations about environmental conditions. It includes metrics and/or graphics of the environmental parameters that shall be controlled during all evaluation.
- Environmental measurements obtained for the calculation of the baseline performance.
- Environmental anomalies.
- Error log: The test operator's record of errors and their solutions.
- Usability data: Data collected during evaluations about usability from the trial user/participant perspective.
- Test operator general observations.

### 7.9 Execution sequence

#### 7.9.1 General

All evaluations should be undertaken in such a way as to allow for meaningful comparison of biometric system performance data obtained across multiple environmental conditions. Trials shall be executed both in the defined reference evaluation environment and in one or more additional evaluation conditions. A consistent set of sequenced activities shall be executed by the test operators and test subjects for each of the evaluation environments. The methodology shall meet the requirements of ISO/IEC 19795-2 and the additional specifications provided within this document.

#### 7.9.2 Pre-test activities

The testing organization shall conduct several activities prior to testing, including the following:

- Examine the biometric system under test and implement the essential testing support application for performing the evaluation. It shall be able to collect the essential information and shall be conformant with the levels of effort and decision policies defined above.
- Plan the evaluation conditions and the proper environment generators.
- Develop the evaluation schedule and how to recruit test subjects.
- Implement legal forms, data forms and guides for test subjects.
- Instruct test operators about how the biometric system works, how to use the evaluation application, how to handle environment generators and all necessary details to carry out the evaluation.
- Calibrate environment generators and check how they work if it is necessary.
- Check calibration of all environmental measurement instruments and recalibrate if necessary.

#### 7.9.3 Test activities

##### 7.9.3.1 Procedures before the first visit

- Recruit test subjects.
- Introduce the biometric system in the evaluation environment specified for enrolment and establish the corresponding environmental conditions.

- Conduct a system operability analysis for enrolment and verification processes.

### **7.9.3.2 Baseline testing**

The baseline testing can be carried out in one of the following ways:

- during the first visit only, or
- during a portion of the follow-on visits.

**NOTE** Collecting baseline values across all of the test subject visits is preferred if it is suspected that system performance due to increased habituation of the subjects can change throughout the test period.

### **7.9.3.3 First visit**

- Explain test instructions to test subjects.
- Train test subject for enrolment.
- Carry out enrolment.
- Generate the first evaluation conditions. Do not forget to introduce the biometric system in the modelled environment before starting to adjust the corresponding values.
- Wait until these conditions are stable. During this time test operators can perform the training for test subjects in verification process.
- Verify test subject in this trial.
- Perform the first session of genuine and impostor transactions. If the environmental conditions are modified due to the interaction of the test subject, between each transaction, it is important to wait for the conditions stabilization and for the biometric system to get acclimatized.
- Generate the next evaluation conditions and repeat the two previous steps for all the conditions to analyse. If applicable execute baseline tests.

### **7.9.3.4 Subsequent visits**

- Remind the test subjects the test instructions for the verification process.
- Establish the first evaluation conditions to test. Remind to introduce previously the biometric system in the environment.
- Execute the set of verification transactions as it was indicated at the first visit as well as the impostor trials.
- Generate the next evaluation conditions and repeat the two previous steps for all the conditions to analyse. If applicable execute baseline tests.

### **7.9.4 Post-test activities**

- Analyse all the information collected during the evaluation.
- Calculate performance rates, graphics and metrics.
- Generate reports including all mandatory data to report.
- Generate post-test briefings to summarize results.

## 8 Operational evaluation

### 8.1 Introduction

Evaluations shall be executed in accordance with ISO 19795-6 with special attention paid to the following:

- environment;
- test period;
- data recording processes;
- performance measurements;
- impostor transactions;
- reporting.

**NOTE** There are several differences between environmental scenario and operational evaluations. In particular, operational evaluations are characterized by the following:

- Operational evaluations use ambient climate conditions rather than strictly a controlled climate conditions.
- Personnel using the system may be operational users, or could be a dedicated test crew, or a combination of both.
- It is possible to augment the testing by controlling other environmental parameter, such as artificial illumination, noise, possibly wind, etc.

### 8.2 Environment

The environment shall be the operational environment for performing enrolments and verifications. Environmental conditions are not controlled in this kind of evaluations; however, the tested environmental parameters shall be recorded. If additional test instruments are required in order to record environmental parameters, these instruments should be located so they modify the user interactions with the biometric system as little as possible.

### 8.3 Test period

Test duration shall be specified considering the environmental parameters to assess and the objectives of the operational evaluation. During this period of time the number of transactions and the corresponding number of test subjects should be calculated to achieve the desired confidence level from the results.

The testing organization shall monitor the environmental conditions to assess and plan/conduct testing when these conditions are most likely to be in the target range. Data collected when the conditions are outside the target range shall be identified and an analysis shall be performed to determine if that data are suitable for inclusion.

**EXAMPLE** If the objective of the evaluation is to analyse trends considering high temperatures, a proper test period is summer because this is a period of time in which it is feasible to analyse such tendencies.

**NOTE 1** Time of day can be a significant test condition if sunlight illumination and illumination angle are included in the test plan.

**NOTE 2** Testing duration is likely to be longer for operational testing due to the variability and uncontrolled nature of the target environmental parameters.

### 8.4 Data recording processes

Methods of recording data shall include recording the environmental parameters to be assessed in the environmental evaluation. These methods shall be in accordance with [6.4](#).

## 8.5 Performance measurements

Evaluators shall report the same performance metrics that ISO/IEC 19795-6 specified for their evaluations. In addition, non-biometric data such as environmental measurements, participant demographic and usability information and error logs should be considered.

## 8.6 Impostor transactions

If false accept rates need to be generated, impostor trials shall be performed.

ISO/IEC 19795-6 describes several ways to conduct impostor tests in operational environments. For environmental evaluations, impostor tests may be conducted in-line with operational use of the system, through dedicated systems, or at dedicated times.

NOTE Performing impostor trials only during a specific interval of time can bias performance results if this period is selected when environmental parameters reach certain values.

## 8.7 Reporting

Environmental measurements shall be reported together with the mandatory performance metrics.



## Annex A (informative)

### Values for environmental parameters

#### A.1 Standard conditions

The conditions of the standard environment are shown in [Table A.1](#).

**Table A.1 — Standard conditions**

<b>Temperature</b>	<b>23 °C ± 3 °C</b>
<b>Relative Humidity</b>	40 % to 60 %
<b>Illuminance</b>	Visible: 300 lx to 1 500 lx
<b>Noise</b>	<60 dB
<b>Atmospheric pressure</b>	86 kPa to 103 kPa

The information in [Tables A.2](#) and [A.3](#) is provided as a reference to similar standard environment definition from other sources.

**Table A.2 — Standard conditions in related standards: temperature, relative humidity and pressure**

	<b>MIL-STD-810G (Controlled ambient)</b>	<b>IEC 60068-1</b>	<b>DEF STAN 00-35 Part 3 Issue 4</b>	<b>OHS Office Ergonomic Guidelines</b>
<b>Temp.</b>	23 °C ± 2 °C	15 °C to 35 °C		21 °C to 24 °C (summer) 19 °C to 22 °C (winter)
<b>Relative Humidity</b>	50 % ± 5 %	25 % to 75 %		40 % to 60 %
<b>Atmospheric pressure</b>	96,45 kPa + 6,6/-10,0 kPa	86 kPa to 106 kPa		—

**Table A.3 — Standard conditions in related standards: illuminance and noise**

	<b>OHS Office Ergonomic Guidelines</b>	<b>CEN EN 12464-1</b>
<b>Illuminance</b>	Common tasks: 300 lx to 400 lx Visual tasks: 600 lx	Common tasks: 500 lx to 1000 lx Visual tasks: >1 000 lx Operating room: 5 000 lx
<b>Noise</b>	55 dB to 65 dB	
	—	

#### A.2 Selection of the evaluation range

There are two approaches to specifying environmental conditions for testing.

A first approach is to utilize the documented operational range of the biometric system, independently of where it will be installed.

A second approach is to utilize environmental conditions as specified as in military standards (MIL-STD-810G and DEF STAN 00-35 Part 3 Issue 4) considering in which region the system will be installed.

MIL-STD-810G provides tables and maps to select it. These tables are based on NATO standards and define four kinds of climate regions: hot, basic, cold, and severe cold.

### A.3 Defining operational environment

The operational range in which the biometric system can work may be defined. There may be a range for each environmental parameter to assess. Such range may be specified using the units described in [6.2.2](#).

When the operational environment will be unknown, it may be defined using two references:

- the range of the biometric system specifications;
- data of a typical environment based on other standards, studies, or publications.

**EXAMPLE** In case of temperature and relative humidity, a typical operational environment can be specified using the same values defined for the basic region in the standard MIL-STD-810G.<sup>[2]</sup> This region covers most of the countries and it is based on NATO standards.

### A.4 Defining extreme conditions

Extreme conditions for each environmental parameter to assess may be defined. These conditions may fall outside the operational range of the biometric system.

When the operational environment is unknown, the extreme conditions may be defined as follows:

- considering a range outside the biometric system specifications;
- using data based on others standards, studies or publications.

**EXAMPLE** In case of temperature and relative humidity, extreme conditions can be defined using similar values to the hot, cold, or very cold regions in the standard MIL-STD-810G.

The extreme conditions may be specified using the units described in [6.2.2](#).

## **Annex B** **(informative)**

### **Test equipment**

#### **B.1 General**

Test equipment is used to perform the following evaluation functions:

- generate and control environmental conditions,
- measure environmental conditions, and
- record environmental condition measurements and biometric performance outcomes.

This Annex provides additional information related test equipment and functionality. This Annex also provides examples for common environmental parameters, e.g. temperature, humidity, and illumination.

#### **B.2 Test equipment for generating and controlling environmental conditions**

##### **B.2.1 General recommendations**

Test equipment used to generate or control environmental conditions should be capable of operating beyond maximum and minimum evaluation condition values. This over-requirement can avoid nonlinear conditions near the limits.

##### **B.2.2 Environment generators for temperature and relative humidity**

The equipment should produce controlled temperature or humidity environments. It should have enough space to introduce a biometric sensor and the user's biometric reference (e.g. hands, arms, direct vision to the face or eyes) and the access to the sensor (e.g. "through-out holes") should allow for typical ergonomic interaction with the sensor, e.g. angle of finger presentation to a fingerprint sensor.

**EXAMPLE** Climatic chamber. In the market there are a wide variety of climatic chambers with different volumes and parameters to control among several ranges. This specification requires that the climatic chamber should be designed with special through-out holes to allow the users' interaction with biometric sensor, keeping the environmental conditions stable.

##### **B.2.3 Environment generators for illumination**

The equipment should produce a controlled illumination area taking into account type of light, intensity and orientation.

**EXAMPLE** Illumination Controlled Area: certain space or room where different bulbs and fluorescent should be allocated. These lights should be laid out in a uniform way and should illuminate capture sensor directly. Depending on evaluation condition requirements and the power emitted from the light sources, the number of bulbs and/or fluorescent and their location will be changed to satisfy the specified ranges.

#### **B.3 Test equipment for measuring environmental conditions**

##### **B.3.1 General recommendations**

Test equipment used to measure control environmental conditions should be capable of operating beyond maximum and minimum evaluation condition values. Besides, these instruments should have

enough capacity for storing the necessary measurements or for connecting other equipment which provides such capacity.

### **B.3.2 Measuring instruments for temperature and humidity**

The equipment should be capable of precisely measuring temperature and humidity.

**EXAMPLE** A climatic chamber has the instruments to measure both the temperature and humidity. Therefore, no further instrument is needed, as long as such equipment does not have an uncertainty above 0,5 degrees for temperature, and 0,5 % for humidity.

### **B.3.3 Measuring instruments for illumination**

The equipment should be capable of precisely measuring illumination.

**EXAMPLE** Spectrometer: This instrument permits to analyse the intensity for a wide range of light spectrum. It is necessary to install a special instrument in the receptor to obtain omnidirectional measurements. Such sensor should be located as near as possible to the biometric capture device. In the case of a fingerprint sensor, you place the lightmeter near finger sensor and take your measurements. Illumination of the human is not our primary concern. In the case of face/iris recognition the light meter should be placed relative to the subject and not to the camera (excluding direct light pointed at the lens). We are concerned here with the illumination level that is on our subject.

## **B.4 Test equipment for recording all results**

For recording significant data generated during tests, an automatic system is recommended. This kind of system makes evaluator's work easier and reduces human error. Report generation is also simplified. This automatic system can have multiple configurations. For biometric related data it can be a part of biometric application. For environmental parameters it can belong to the measurement instruments, an independent application, or a mixture of both. Evaluators may decide on their preferred method of recording results.

## Bibliography

- [1] ISO/IEC/TR 19795-3, *Information technology — Biometric performance testing and reporting — Part 3: Modality-specific testing*
- [2] MIL-STD-810G, Test Method Standard for Environmental Engineering Considerations and Laboratory Tests, presently (2008) version G

