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Public swimming pools — Computer vision systems for the detection of drowning accidents in swimming pools — Safety requirements and test methods

Piscines publiques — Systèmes de vision par ordinateur pour la détection de noyades en piscines — Exigences de sécurité et méthodes d'essai

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Foreword

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This document was prepared by Technical Committee ISO/TC 83, *Sports and other recreational facilities and equipment*.

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Introduction

Currently available epidemiological data show that despite the presence of lifeguards, drowning [which, according to the World Health Organization (WHO), is the process of experiencing respiratory impairment from submersion/immersion in liquid] remains in public swimming pools with entrance fees. A certain number of studies[2][11] together demonstrate that for several reasons (physiological, cognitive, architectural, organizational, etc.), lifeguards may sometimes find themselves in difficulty when watching over swimmers, knowing that a potential risk of a drowning accident may occur.

It is important to bear in mind that a lifeguard can supervise and inform swimmers to help ensure their safety as well as anticipate and intervene early to prevent an accident from occurring.

Computer vision systems do not save people from drowning, as saving a drowning person necessarily requires human intervention.

Installation and use of computer vision systems cannot serve as a reason to reduce human monitoring of swimming pools, unless a robust risk assessment does indicate this is possible without compromising safety, with reference to applicable national regulations, if any.

In addition to the safety organization, these tools are solely for use by a competent person, who received prior training in the operational performances of these systems in accordance with the manufacturers' and the swimming pool operators' instructions.

Not all possible drowning accidents can be detected by the systems described in this document, e.g. persons floating on or just below the water surface. Although the current state-of-the-art does not allow 100 % effectiveness, for several years, these technologies have proved their worth worldwide, by regularly helping lifeguards to identify potential drowning accidents that they had not observed.

While it is possible to retrofit this type of equipment to an existing pool, consideration of its introduction is best at the pool design stage.

In order to really enhance the drowning prevention in swimming pools, computer vision systems are designed to:

— scan continuously and with redundancy the pool basin;

— detect mathematically a solid mass, without trajectory, lying at the pool basin bottom;

— trigger electronically an alarm after the detection;

— limit false alarms by automatically differentiating a solid mass from light and shadow projections on the texture of the pool basin and by discriminating, without human intervention, a motionless solid mass above and below the water surface.

A trained competent person cannot completely rely on such a system because:

— the system has limitations, which are covered in training for using the system;

— the system's performance can be compromised by various factors, which the trained competent person would be informed of automatically in real time.

Computer vision systems are foreseen to support the competent person in detecting drowning accidents at the pool basin bottom and reacting faster by saving precious seconds.

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents concerning computer vision technologies for the detection of drowning accidents in swimming pools, given in 3.1.

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Public swimming pools — Computer vision systems for the detection of drowning accidents in swimming pools — Safety requirements and test methods

1 Scope

This document describes the minimum operational, performance and safety requirements and test methods for computer vision systems used to detect drowning accidents.

This document does not apply to the systems used in domestic swimming pools and pool basins with a surface area of less than 150 m^2.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
computer vision system for the detection of drowning accidents
automated system including means for digitizing series of images of people in the *pool basin* (3.11), means for comparing and analysing digitized images and decision means for setting off and sending an *alarm* (3.5) to *trained staff* (3.7) when a *detection* (3.3) occurs

3.2
drowning
process of experiencing respiratory impairment from submersion/immersion in liquid

Note 1 to entry: Outcomes are classified as death, morbidity and no morbidity.

[SOURCE: World Health Organization]

3.3
detection
recognition of a total and prolonged immersion at the bottom of the *pool basin* (3.11) of a stationary solid mass such as a person or object

3.4
monitoring
active and constant observation of people in the *pool basin* (3.11) with the aim of preventing *drowning* (3.2) risks

3.5
alarm
notification by the computer vision system of a *detection* (3.3) to the identified *trained staff* (3.7)

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3.6
competent person
designated individual who has acquired through training, qualifications or experience, or a combination of these, the knowledge and skills enabling that person to perform a specified task

3.7
trained staff
on-duty *competent person* (3.6), in charge of surveillance and trained in the use of the *computer vision system for the detection of drowning accidents* (3.1), and with access rights to the system

3.8
false alarm
alarm (3.5) set off for reasons other than *detection* (3.3)

3.9
alarm set off time
time from the moment that a solid mass is fully immersed, on the pool bottom and stationary, until the *alarm* (3.5) is activated

3.10
swimming pool
facility, with one or more water areas, intended for swimming, leisure or other water-based physical activities

3.11
pool basin
water tank where water-related activities can take place

4 Requirements

4.1 General

Computer vision systems are designed to complement lifeguards or trained staff and are not designed to reduce lifeguard supervision or staffing levels.

The equipment and materials used shall be suitable for the environment in which their installation is intended (immersion depth, very high hygrometry, chemically aggressive atmosphere, etc.).

Equipment and materials installed in a ≥60 % hygrometry environment shall be at least IP65 (degrees of protection provided by enclosures). Equipment and materials for use in a submerged environment shall be IP68 (see IEC 60529).

For information, a typical rescue scenario is available in Annex A.

4.2 Technical study

Prior to any installation of a computer vision system for the detection of drowning accidents, a technical study shall be carried out by the supplier in consultation with or based on information provided by the swimming pool's owner/operator. Depending on the computer vision system proposed, the technical study is used to quantify and to position the equipment making up the system, such as cameras, central processing unit, alarm tools and related equipment, in a document.

The study shall also specify:

— the minimum level of artificial lighting required above and below the water surface (illuminance in lux) to enable detection by the computer vision system in accordance with the performance requirements;

— areas of the pool basin in which the computer vision system will be able to provide detection;

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— the alarm set off time in seconds (see 4.3.1).

A technical drawing of the pool basin(s) shall be provided in order to show the areas of coverage and non-coverage by the computer vision system. The pool basin area(s) covered shall be clearly identified. The technical study shall make it possible to optimize the performances for the system when in operation. The factors to consider are:

— the general swimming pool architecture (layout and potential effect on the swimming pool of bay windows and lightwells, etc.);

— the pool basin dimensions (shape, gradient, minimum depth and maximum depth);

— the texture and colour of the pool basin lining (e.g. tiling, stainless steel, PVC, resin);

— the specific equipment (moveable floor, moveable bulkhead, wave machine and all equipment able to generate water movements);

— maximum instantaneous frequency of use of the swimming pool;

— the water clarity;

— the swimming pool attractions (e.g. waterslide);

— the alarm reception coverage area of mobile devices.

The technical study shall be part of the contract between the supplier and the responsible parties (e.g. swimming pool operator).

4.3 Performance requirements

4.3.1 Alarm set off time

The alarm set off time shall be ≤15 s and fixed to an accurate value.

The current alarm set off time shall be displayed on the system interface.

The alarm set off time is built-in and shall not be able to be changed by staff.

4.3.2 Areas covered

The areas covered by the computer vision system shall be compliant with the technical study carried out before system installation. Each trained staff shall be aware of these areas.

The computer vision system shall make it possible to temporarily create basin areas in which detection is disabled in order to be able to manage specific activities, such as rescue drills or immersion of training equipment. The trained staff shall be able to freely define these areas in order to temporarily deactivate the alarm. The trained staff shall determine the duration of non-detection for each zone created. Detection shall be reactivated automatically when the time has expired. The computer vision system interface shall permanently indicate the position of these zones while they are activated. The trained staff shall be able to change the non-detection settings (zone and duration) at any time.

4.3.3 Detection performance

Compliance to the detection test method described in 5.3 is achieved if the detection rate is ≥80 % (under the set lighting conditions).

One alarm for every detection shall be set off.

Each time the trained staff is activating his user session, the computer vision system shall show in at least two different ways that the used hardware is in operation.

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The computer vision system shall inform trained staff immediately when the detection performance is deteriorating.

The computer vision system interface shall display at any time the level of deterioration in performance and state its nature.

The system shall be able to set off alarms without any manual calibration between detections.

The computer vision system shall be able to simultaneously detect multiple incidents at different places in all pool basins covered by the system.

4.3.4 False alarm rates

During normal use of the pool basin (that is to say outside specific activities such as aqua-aerobics, aqua-biking and the use of play structures, etc.), there shall not be, on average, more than five false alarms per day, per pool basin, with a system during public opening hours over a 30 day period.

4.4 Data communication and management

4.4.1 General

A data and alarm log covering the last 30 days during public opening hours shall be saved unless regulatory provisions state otherwise.

4.4.2 Alarm data

If a siren is used, alarm sound shall be different from any other in the swimming pool.

If the computer vision system is fitted in several pools, it shall state the references of the pool basin concerned by the alarm.

The computer vision system interface shall enable trained staff to stop the alarm.

The date, time, images and position of the detection shall be stored on an internal hard drive of the computer vision system.

All alarms shall be transmitted.

All alarms shall be received in at least two ways by the trained staff. At least one shall be by a wired link. There shall be at least one visible and one audible alarm. Alarm examples include siren, smartphone, mobile devices such as pager's screen, alarm display panel, or tablets.

Any wireless alarm device shall be checked to ensure it works in the alarm reception coverage area defined in the technical study.

When the alarm is triggered, the following information shall be transmitted as a minimum:

— alarm signal;

— affected pool basin;

— accurate position ±2 m of the detection in the affected pool basin.

4.4.3 Operational data

All data relating to use (including date and time of session opening and closing) shall be stored in the form of a log on the internal hard drive of the computer vision system.

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5 Test methods

5.1 General

The computer vision system for the detection of drowning accidents shall not go-live before carrying out successful tests in the pool basin fitted with the system. The tests shall be carried out by the supplier, within 3 months after the start of the system commissioning phase. It serves to test the performance of the system installed.

The results of the tests shall meet the requirements of Clause 4 and the alarm shall be received by all alarm notification equipment in use (e.g. siren, screen, alarm display panel, mobile devices such as pagers, tablet computers). All wireless devices shall be tested and functional for the entire alarm reception coverage area specified in the technical study.

5.2 Non-detection test

5.2.1 Non-detection test preparation

The following elements are required in order for the non-detection test to be carried out:

— chronometer;

— competent swimmer.

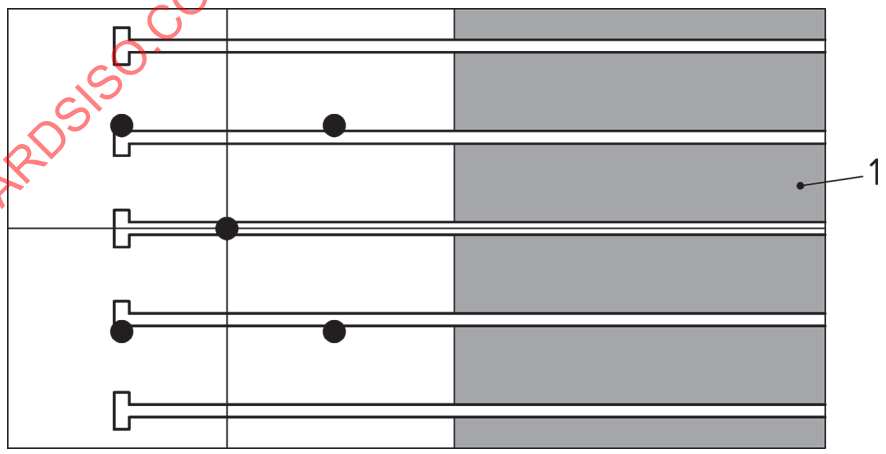
5.2.2 Non-detection test procedure

This test shall be carried out if the area covered by the computer vision system has a depth ≤1,5 m, including when a moveable floor is present.

Subdivide the pool basin or area ≤1,5 m deep into four quadrants.

Instruct a competent swimmer to stand still at the centre of each quadrant and in the centre of the pool basin or area for 35 s to 40 s (see Figure 1).

EXAMPLE See Figure 1.



Key

1 grey zone: deep end (>1,5 m water depth)

● positions of the competent swimmer

Figure 1 — Example of subdivision of an area, in four quadrants, with a pool basin depth ≤1,5 m, with the five positions of the competent swimmer

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For each of the five positions, count the number of seconds using the chronometer and after 35 s to 40 s, note whether the computer vision system detects the swimmer or not.

The swimmer shall not be detected more than twice for the total of the five positions.

NOTE The depth of ≤1,5 m was chosen in order to cover the areas of the pool basin in which an individual is able to stand while remaining immobile.

If the system fails the non-detection test, then it does not meet these document requirements and further testing according to 5.3 is not required and the system shall receive non-compliance.

5.3 Detection test

5.3.1 General

The detection test described in this document is intended to:

a) verify the basic functions of the system;

b) prove that the monitored area, defined in the technical study, is covered.

An optional additional test under real operational conditions is recommended, e.g. according to the principles of this document, resulting from a risk assessment in the swimming pool or due to national and/or local regulations.

After commissioning and sign off of the system, swimming pool operators can carry out an optional operational test during normal operational use (real world) on a regular basis. A record of test results shall be made containing the following information as a minimum:

— the number of swimmers in the pool basin;

— their location in the pool basin;

— lighting conditions;

— water clarity;

— time and date.

This method is not reproducible; however, if the operational detection test raises any concern, then the system shall be tested following Clause 5 (excluding the optional operational test) to ensure there are no system issues.

The results of the optional operational test and recorded information shall be passed onto the manufacturer to help development and continual improvement of the system.

5.3.2 Detection test conditions

In order to be reproducible, the detection test shall be carried out in strict accordance with the following conditions.

— There shall be no swimmers in the area covered by the computer vision system.

— The water shall be compliant with legislation, and notably clear, meaning that the swimming lines or a dark coloured marker measuring 30 cm placed at the deepest point should be clearly visible.

— Lighting shall be artificial only, and the level of lighting on the water body shall be at least equivalent to that requested by the supplier in the technical study carried out by them prior to installation of the computer vision system for the detection of drowning accidents.

— The computer vision system central processing unit shall not be connected to any external network while the detection test is being carried out.

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— If the pool basin has a moveable floor, the detection test shall be carried out twice. Once with the moveable floor at maximum depth and a second time with the moveable floor placed at 1,5 m below the surface of the water.

NOTE 1 Reproducibility requirements do not make it possible to carry out the detection test in natural light, as the luminous flux of natural light varies over the day, depending on sunshine hours and conditions.

NOTE 2 1,5 m depth was chosen in order to cover the usual non-swimmer depth.

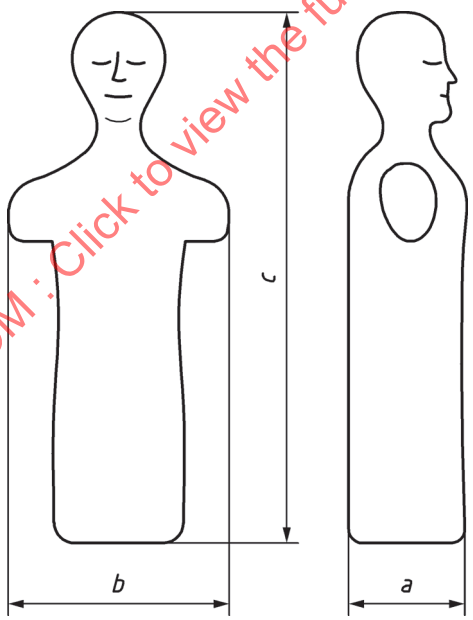
5.3.3 Test preparation

The following elements are required in order for the detection test to be carried out:

— chronometer;

— dummy: in order to standardize the measurement and to replicate actual operating conditions, the dummy shall measure between 65 cm and 100 cm (length) × 25 cm and 50 cm (width) × 18 cm and 25 cm (depth), and weigh between 4 kg and 10 kg out of the water (see Figure 2). The dummy should be wearing a woman's (one-piece) swimsuit, in a dark colour (to compensate for the lack of contrast from the dummy's texture);

— rope: the rope length is equal to at least the sum of the length and maximum depth of the pool basin. One end of the rope shall be attached around the dummy's head. In order to make it easier to move the dummy, a knot is tied in or a mark made on the rope at regular intervals. The interval is the distance between two positions per lane as described in 5.3.4.



Key

a depth
b width
c length

Figure 2 — Example of test dummy dimensions

5.3.4 Distribution of detection measurements during the test

In order to be representative, the detection measurement shall be carried out in all areas covered by the computer vision system.

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To carry out the measurement, each basin equipped with the computer vision system is given in a table (see Figure 4).

For each basin equipped with the computer vision system, a measurements table is set out according to the following procedure:

— measurement of the length (l) and width (w) of the basin (for non-rectangular basins, l and w are measured on the rectangle actually around the basin);

— the basin is divided width-wise (w) into lanes 2 m wide. If necessary, the result of w/2 should be rounded to the nearest whole number;

— in order to determine the number of positions per lane, divide the length (l) of the basin by 4. If necessary, the result of l/4 should be rounded to the nearest whole number;

— the measurement positions on patterns (e.g. designs, swimming lines, grids) shall be in proportion to the surface area of the patterns with respect to the total surface area of the zones covered.

The resulting layout is the measurements table. The diagram shall also take into account the configuration of the pool basin (depths, starting blocks, cardinal points, etc.).

In order to ensure that the measurements are effectively representative, the total number of positions shall be at least equal to 20. If necessary, they should be proportioned again to reach the required minimum.

Table 1 provides typical number of test positions for rectangular pools. Figure 3 is an example for a 25 m × 15 m rectangular pool.

The following rule applies for rounding:

— [0, 0,5[shall be rounded to the lower whole number;

— [0,5, 1[shall be rounded to the higher whole number.

EXAMPLE 7,5 is rounded up to 8.

Table 1 — Typical number of test positions for rectangular pools

Length (l) of the area covered (m)	Width (w) of the area covered (m)	Number of positions per lane	Number of lanes	Total number of measurements
15,00	10,00	4	5	20
20,00	10,00	5	5	25
25,00	10,00	6	5	30
25,00	12,50	6	6	36
25,00	15,00	6	8	48
25,00	20,00	6	10	60
25,00	21,00	6	11	66
25,00	25,00	6	13	78
50,00	15,00	13	8	104
50,00	20,00	13	10	130
50,00	25,00	13	13	169

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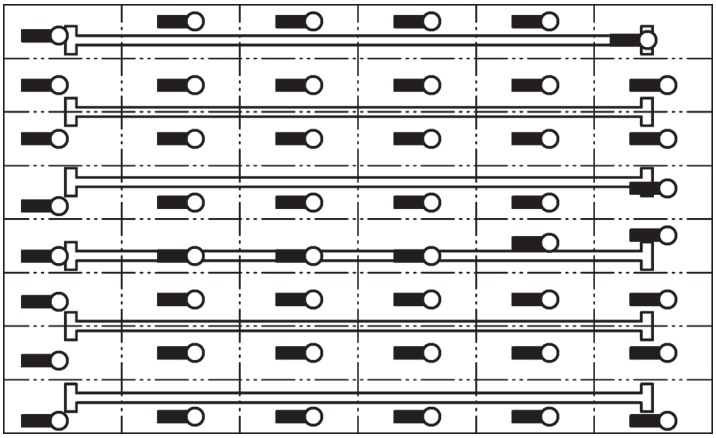

Figure 3 — Example of measurement distribution position for a 25 m × 15 m rectangular pool with patterned surfaces

Y/N/NC	Y/N/NC	Y/N/NC	Y/N/NC
Y/N/NC	Y/N/NC	Y/N/NC	Y/N/NC
Y/N/NC	Y/N/NC	Y/N/NC	Y/N/NC
Y/N/NC	Y/N/NC	Y/N/NC	Y/N/NC
Y/N/NC	Y/N/NC	Y/N/NC	Y/N/NC
Y/N/NC	Y/N/NC	Y/N/NC	Y/N/NC
Y/N/NC	Y/N/NC	Y/N/NC	Y/N/NC

Key

Y detected (yes)

N not detected (no)

NC not covered

Figure 4 — Example of measurements table

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5.3.5 Detection test measurement protocol

The detection test is carried out on the basis of the current alarm set off time described in 4.3.1, a ±2 s tolerance being added in order to take into account starting of the chronometer, which is not as accurate as an automated system.

Begin by immersing the dummy in the pool basin at the far end of the first lane and wait until the dummy is lying immobile on the pool basin floor.

Using the chronometer, count the number of seconds it takes for the alarm to go off from the moment the dummy becomes immobile and check the ±2 m accurate position in the affected pool basin (see 4.4.2).

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Check each time that at least one piece of equipment used (siren, screen, alarm display, mobile devices such as pagers, tablet computers, etc.) shows the number of seconds elapsed from alarm set off along with the precise alarm position in the pool basin.

Record the result in the measurement table.

EXAMPLE If the current alarm set off time is 15 s:

Y = yes, if the alarm goes off within 13 s to 17 s and that the position in the affected pool basin is respected at ±2 m;

N = no, alarm does not go off within 17 s or if the alarm goes off before 13 s, or if the ±2 m accurate position in the affected pool basin is not respected;

NC = not covered, if the position is in an area not covered by the computer vision system) (see Figure 4).

Stand at the opposite side of the pool basin and pull the dummy in the same direction using the rope.

The knots or marks on the rope are used to pass from one position to the next.

Repeat in each section of the lane and in each lane, and note the results in the measurement table. Detection performance shall be determined at the end of the measurement, by dividing the number of Y by the total number of positions (Y + N). The result shall be ≥80 %.

Take the appropriate actions if the system does not pass the detection test.

5.4 Test report

The test report is part of the system documentation and shall contain the following data as a minimum:

a) the name and address of the person performing the test and place in which the test was carried out;

b) a clear identification of the test report (i.e. a reference number) and of each page along with the total number of pages in the report;

c) a reference to this document, i.e. ISO 20380;

d) the name and address of the swimming pool;

e) the name and job title of the swimming pool operator;

f) the name and address of the supplier of the computer vision system for the detection of drowning accidents;

g) identification and description of the computer vision system for the detection of drowning accidents, notably including the number and type of cameras dedicated to the pool basin:

- underwater cameras: Yes ☐ No ☐;
- number of underwater camera;
- overhead cameras: Yes ☐ No ☐;
- number of overhead camera;

h) an accurate description of methods or procedures implemented;

i) dimensions and type of wall and floor:

- length, in m;
- width, in m;

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— minimum depth, in m;

— maximum depth, in m;

— floor type (please specify);

— wall type (please specify);

— specific equipment (moveable floor, moveable walls, etc.);

j) lighting conditions at the time of the test:

— ceiling lighting: Yes ☐ No ☐;

— wall lighting: Yes ☐ No ☐;

— underwater lighting: Yes ☐ No ☐;

— state average lighting level at pool basin surface;

k) basin pool water clarity at the time of the test:

— compliant ☐;

— non-compliant ☐;

l) date of measurement (DD/MM/YYYY);

m) time of measurement:

— measurement start time (system time HH:MM);

— measurement end time (system time HH:MM);

n) all deviations, additional elements or exceptions observed during the test and any other information likely to be important;

o) measurement results, with tables, drawings and pictures and any failings or defaults observed;

p) signature and qualification of the person in charge of the technical aspects of the test and the publication of the report.

6 Regular testing

6.1 Daily testing

Trained staff shall test the computer vision system daily by immersing a dummy at a random position in the pool basin before public opening hours for pool basins covered by the computer vision system. Trained staff shall note the test results in a system log and shall take the appropriate actions if the system does not pass the daily test.

6.2 Half-yearly testing

Trained staff shall carry out a full test once every 6 months according to the test method described (see 5.1 to 5.4). Trained staff shall note the half-yearly test results in the computer vision system log and shall take the appropriate actions if the system does not pass the half-yearly test.

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