WHO/UNFPA Guidance on Testing of Male Latex Condoms
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1 Introduction

Condoms are tested as per the WHO/UNFPA specification by independent laboratories. These laboratories have to be accredited to ISO 17025 for the test methods in ISO 4074 in order to be considered for testing services. The following guidance has been developed to assist the laboratories to standardize testing and reduce variability. The guidance is meant to supplement the specific ISO 4074 tests.


- Condom length can be measured directly, using a suitable calibrated mandrel, or automatically, using one of the instrumented machines now available.
- The automatic methods have the advantage that data can usually be transferred directly to any computerised record system, although it is important that the equipment is validated and regularly calibrated following the methods recommended by the manufacturer.
- A standard mandrel (described in ISO 4074) is used to normalise the measurements, as different condom designs can have different shapes at the teat and closed end.
- As a rolled condom can retain a memory of the roll when unrolled, it is permitted to stretch the condom a little (no more than 20 mm, and no more than twice) when unrolled, to help remove any wrinkles persisting after the unrolling.
- Condoms can be measured lubricated, but handling a lubricated condom can be difficult, as the lubricant can cause the condom to stick to itself in pleats or creases. A lubricated condom may also not hang freely over the mandrel, and if stretched, can be held in the extended state by the lubricant. The condom can be powdered to ease the handling problems, as described in the standard, with or without removal of the lubricant.
- Owing to the way the bead is formed, the condom length may not be exactly the same at points around the condom. It is important to measure the length at several points and record the minimum. The instrumental methods may do this automatically.
- When measuring the length manually, it is important that the measurement is taken with the bead of the condom at eye level, to avoid any parallax errors. It may be easier to position the mandrel on a stand to bring it up to the eye level of the operator. Again, the instrumented methods will take this into account.
- Note that the condom length should be measured to the nearest 1 mm.

- Condom width can be measured directly, using a ruler, or automatically using one of the automated machines now available.
- The automatic methods have the advantage that data can usually be transferred directly to any computerised record system, although it is important that the equipment is validated and regularly calibrated following the following methods recommended by the manufacturer.
- When measuring directly, using a ruler calibrated in mm, it is important that the condom is positioned so that the axis of the condom is exactly perpendicular to the ruler.
- Note that the end of a ruler can get worn and the corners rounded, so it is better to position the condom to use another point, (e.g. the 10, 20 or 100 mm index) as the zero. The condom should be measured at the narrowest point within the range 20 to 50 mm from the open end.
- Condoms can be measured lubricated, but handling a lubricated condom can be difficult, as the lubricant can cause the condom to stick to itself in pleats or creases. Gently manipulate the condom to smooth out any such creases, ensuring that the condom is not stretched, as sometimes the lubricant can hold the condom in an extended state. It may be better to remove the lubricant and lightly powder the condom, especially if the same condoms will be used for the determination of length.
- Note that the condom width should be measured to the nearest 0.5 mm, which will require the measurement to be interpolated if the scale is in whole mm.


ISO 4074 allows two methods for the measurement of thickness, one based on the direct measurement by a micrometer, and the other by mass. The mass method was introduced owing to the fact that the precision and reproducibility of the micrometer method was found to be relatively low. One of the reasons for this is to accommodate condoms where the surface is not smooth, and also it is thought to be that the preload applied to the foot of the micrometer to ensure good contact with the material under test can compress the film slightly. In some cases this preload has also been found to be well outside the required range.

Any lubricant on the condom is removed by washing or wiping the condom with propan-2-ol, and removing the lubricant can make the condom difficult to handle. If any powder is added to facilitate handling and sample preparation, this must be removed before measuring.
The thickness of a condom can vary along and around the condom, and for this reason thickness is measured at three points on the condom, the mid-point (± 5 mm) of the condom, 30 ± 5 mm from the closed end and 30 ± 5 mm from the open end. If the micrometer method is used, then three measurements, approximately equally spaced around the condom, are taken at each location and averaged. The mass method, of course, will give the average thickness of the sample being measured.

4.1 Mass method.

The mass method calculates the volume of the sample by dividing the mass of the sample by the density of natural rubber. If the length and width of the sample are known, then the thickness can be simply calculated. The formula, as given in Annex F of ISO 4074:2015, is:

\[
\text{Thickness (in mm.)} = \frac{1}{0.92} \times \frac{1}{A} \times m
\]

using a density of 0.92 g/cm³, and where A is the area of the test piece (length in mm. x 20) in mm² and m is the mass of the sample in mg. If the condom is not parallel-sided, then measure both of the long sides and use the average. The method specifies the test piece for tensile testing as the sample. This has the advantage that many laboratories already have the cutting die to give a 20 mm. wide ring test piece from a condom. Whilst there will be very slight differences in the density of the condom, caused by differences in the formulations, these will not cause any significant changes in the calculated thickness.

4.2 Micrometer method.

The micrometer method measures the thickness of the sample directly using a calibrated dial or digital micrometer capable of reading to the nearest 0.001 mm. If the condom is textured, then micrometer measurements on the textured portion can give false results. In this case measure the condom at a non-textured region as close as possible to the specified points (and report this with the results). Alternatively, the mass method could be used. Zero the gauge after measuring each sample. Because of the compressibility of rubber, it is essential that the foot pressure is within the specified 22 ± 5 kPa, and the foot pressure should form part of the regular calibration procedure for the gauge. Note that powder or lubricant on the shaft of the gauge may increase friction when the gauge is used, altering
the foot pressure. For this reason, it is important to ensure that the gauge is kept clean. It is essential that the foot of the micrometer is exactly parallel to the platen. If not, then the edge of the foot, rather than the face, will contact the sample. Under the defined load, the edge can dig into the sample and give a false reading. A photograph of an incorrectly adjusted gauge is shown in figure 1. Correct alignment can be checked by measuring a slip gauge or a feeler gauge using several positions around the very edge of the foot of the micrometer (figure 2). If the micrometer is correctly set up the readings will be the same from all sides of the foot.

*Figure 1.* The foot of this micrometer is *incorrect* and will give the wrong reading.
Figure 2. Showing the measurement positions to confirm that the foot is parallel to the platen.

Note that, according to clause 5.5.12 of ISO 17025: 2005, test equipment shall “be safeguarded from adjustments which would invalidate the test result”. It is therefore recommended that parts of the gauge that can be adjusted, such as the bezel on a dial or any adjustments on the gauge mount, are made tamper-evident. A small sticky label, signed by an authorized person and placed over the part is a simple way to achieve this.


The burst properties of condoms are important properties, and are frequently one of the parameters that show up differences in inter-laboratory testing. There can be many reasons for testing variability, of which the following are thought to be the most important.

- Loading of the condom onto the mandrel.
- Correct inflation length.
- Slippage of the condom during inflation.
• Correct calibration of pressure and volume measuring equipment.
• Any corrections for variations in atmospheric pressure owing to the altitude of
the test laboratory.

Note that recommendations for calibrating the air inflation equipment are given in

5.1 Loading of the condom onto the mandrel.

Condoms are almost always tested lubricated, and a lubricated condom can be
difficult to handle. One of the problems resulting from this is that the **condom may be stretched too far on loading**. In this situation, especially with burst test
machines that use a wide supporting mandrel, the lubricant can cause the condom
to stick to the mandrel or inflation cuff, preventing the extended condom from
recovering fully. As a result, the tested length of the condom is less than it should
be. This will lead to a falsely low burst volume and a higher burst pressure.
The opposite situation can occur, especially if the operator is trying too hard to
avoid stretching the condom! This can give a condom that is **positioned too loosely on the mandrel**. In this case the tested length will be greater than
specified, giving burst volumes that are erroneously high, and burst pressures too
low.
The correct way to load the condoms is as follows:-
• Remove the condom from the pack, taking care not to damage it (it is
  recommended that gloves or finger cots are worn).
• Whilst it is permitted to unroll the condom before loading it will generally
  be much easier to unroll the condoms directly onto the supporting rod or
  mandrel.
• Place the rolled condom onto the top of the supporting rod or mandrel, and
  using the finger tips stroke the condom down, **a little at a time, allowing the condom to relax for a few seconds after each stroke**.
• Ensure that the condom is not stretched as it is unrolled over the
  supporting rod/mandrel

5.2 Ensuring the correct inflation length

As described in 5.1 above, ensuring the correct length of the condom to be inflated
is important. Assuming that the condom is loaded correctly, this length will be
dictated by the length of the supporting rod or mandrel. This will generally be
adjustable, and can be checked as follows.
• Load the condom onto the test machine.
• Clamp the condom.
● Mark the condom, using a suitable pen or marker, as closely as possible to the top of the external clamping collar. Depending on the type of burst test machine, clamping the condom will also start the inflation. In this case the inflation needs to be stopped as soon as possible so the condom can be marked, or the condom marked as soon as possible and the test aborted so that the condom is not inflated and burst.

● Measure the length of the condom to the mark, using the condom length measuring mandrel described in Annex D of ISO 4074. The length to the mark should be 150 ± 3 mm.

● If the tested length is outside of these limits, adjust the machine and repeat the measurement to confirm that the tested length is correct.

● Repeat for each inflation head on the test equipment.

5.3 Checking that the condom does not slip during inflation.

Most air inflation equipment clamps the condom by inflating an elastic cuff against a rigid collar, clamping the condom in between. Obviously, no matter how carefully the condom has been loaded onto the test equipment, if it is not firmly held by this clamping mechanism and the condom slips during the test, then errors will be introduced into the results. The effectiveness of the clamping system can be checked in a similar fashion to the inflation length described in 5.2 above. In this case, after marking the condom allow it to inflate whilst watching the mark. Any slippage in the clamping mechanism will be shown by the mark moving upwards (usually erratically) as the condom inflates. It is also important to check that these cuffs do not leak, as any unmonitored air entering the condom will give false results. This can be checked by inflating the cuff, turning off the air supply (if the machinery will allow this) and checking that the cuff remains inflated over a period of several minutes. Again, check all the inflation heads on the test equipment.

5.4 Calibrating the volume and pressure measuring equipment.

Owing to the different types of condom burst equipment used in the industry, no recommendations on the calibration and verification procedures can be made here, other than to calibrate the machines following the manufacturer’s instructions. The calibration interval again can be specified by the manufacturer, and will typically be between one and four times a year, although if the equipment is subject to heavy use it may be worth calibrating more frequently. If there are any
reasons to suspect that the results from a particular machine or test head are not accurate, then investigation and re-calibration should be undertaken immediately.

5.5 Correcting for variations in atmospheric pressure owing to the altitude of the test laboratory.

The calibration procedure for inflation test machines will often require the average atmospheric pressure to be entered. It is important that this is adjusted accordingly, especially for test laboratories situated at high altitudes. More detailed instructions will usually be found in the manufacturer’s support literature, or can be sought directly from the manufacturer.

5.6 Other factors to consider in the burst testing of condoms

- Ensure that the flow rate is within the specified range of 24-30 dm$^3$/min.
- When a condom is inflated there is a region of high stress between the part of the condom that is firmly clamped, and the adjacent freely expanding part. Owing to the characteristics of latex dipping, this zone is also usually the thinnest. Care must be taken to remove any potential for damage in this area. ISO 4074 specifies that the edge of the rigid collar is rounded with no sharp edges, but this edge should be checked regularly to ensure that it has not been nicked or damaged and is still adequately smooth.
- Inflation testing machines can test a lot of condoms between service intervals, and in general these condoms will be lubricated. It is not uncommon for lubricant to build up in the various holes supplying air to the condom, or the piping connecting the condom to the pressure transducer. Not only can this lubricant build-up affect the accuracy of the test procedures, but contamination of the pressure transducer by lubricant can mean an expensive replacement. Powder and fragments of rubber can also partially or completely block these apertures. It is recommended that there is a daily inspection and cleaning of these apertures, and that the piping to the transducer is inspected and cleaned regularly.
- Be aware of the possibility that the test heads in a multi-headed inflation test machine can differ. Monitor the individual heads, and if any of them appear to be giving consistently different results to the others investigate, and rectify if necessary.
- Consider storing a batch of control condoms, and testing a few of them, depending on the number of test heads on the machine, every day before starting to use the inflation equipment. If the results from these control
condoms are within the expected trend, that gives an assurance that the equipment is working properly. It can also be useful in detecting and quantifying any differences between operators. Graphing the results on, say, a mean and range chart will help identify if any significant changes occur.


It is a requirement of ISO 4074:2015 that the condoms should comply with the key physical property requirements (that is burst volume and pressure, freedom from holes and package integrity) throughout their claimed shelf life. The shelf life can only be established by a real-time study carried out at 30° C (+5, -2° C). However, a provisional shelf life can be claimed whilst the real-time study is in progress, provided that satisfactory data from accelerated aging studies are available to support the claim. A full description of the requirements for real-time and accelerated aging stability studies is given in Annexes K and L of ISO 4074:2015.

Points to note when conducting these aging studies are:-

- The condoms used in the studies must comply with the requirements of ISO 4074. The studies can only be done with condoms that have been stored in bulk for the maximum period of time specified by the manufacturer between dipping and packaging in individual sealed containers. This period shall not exceed 2 years.
- Minimum stability requirements (clause 11.2) must be established.
- Three different lots of condoms must be used in the studies.
- Select and condition sufficient extra condoms to cover some repeat testing if necessary.
- Ensure that there are contingency arrangements in place in case of equipment breakdown or power failures. You do not want to have to start the studies again from scratch.
- Ensure that the calibration and measurement of temperature are monitored correctly and the trends are reviewed to pick up early warning signals for initiating appropriate corrective and preventive actions.
- Ensure that the system of recording temperature and raising alerts in case of outages in temperature conditions are in good state of repair throughout the long period of stability studies and the alert signals are responded to immediately.
- The claimed shelf life cannot exceed 5 years from the date of manufacture.
The date of manufacture can be either the date of dipping or the date the condoms were sealed in their individual containers. Note that the labelled date of manufacture cannot be more than two years from the date of dipping.

Monitor the physical properties of the condoms at intervals during the real-time study. Two methods are described in clause K.2.4 of the standard. These are:

- measure the airburst properties of a sample of 125 condoms from each lot, and compare against the requirements of the standard, using the AQL of 1.5 (accept on 5 failures or fewer, reject on 6 or more). If one of the three lots of condoms fails the study can continue, but must be stopped if more than one set of samples fails.
- alternatively, measure the airburst properties of a set of 32 condoms from each lot. Calculate the standard deviation (or 95% confidence interval) for burst volume and pressure. If the mean value minus 3 times the standard deviation approaches the minimum limits defined in the standard (as described in the note to clause K.2.4) this can indicate that the condoms will not pass the requirements of the standard if the study is continued, and the stability study should be terminated.

If the manufacturer has condoms where the shelf life has been confirmed by a real-time study, then these condoms can be used as controls in an accelerated aging study of a new or modified condom, as described in clause L.3.

If there are no condoms to act as controls in this way then the provisional shelf life must be estimated following the procedures in clause L.2.

Existing condoms whose shelf lives were established following the procedures of earlier versions of ISO 4074 (i.e. 2002 and 2014) can be considered to be compliant.

If any significant changes are made to the condom formulation, manufacturing procedures or packaging, then the shelf life will need to be re-confirmed. A significant change, as explained in ISO 16038, is one that can be regarded as having the potential to affect performance adversely. If a change is deemed by the manufacturer not to require confirmation of shelf life, it is strongly recommended that the reasons for this decision and all supporting test data are written up and filed.

7 Freedom from Holes

7.1 ISO 4074:2015, Annex M
The ISO 4074 standard has two methods for performing the test for holes. The volume of water dispensed is dependent upon the average length and average width (taken at 75±5 mm from the closed end excluding the reservoir tip) of 13 condoms as described in the standard.

A. The Water leak Test (Hang and Roll)

A suspended condom is filled with a specified volume of water and examined for visible water leakage through its walls. In the absence of any leakage, the condom is then rolled on coloured absorbent paper, which is subsequently examined for signs of leakage of water from the condom. The test must be carried out exactly as described in the Standard.

Points to note:

- Before testing, using calibrated apparatus, ensure that the volume and temperature of the water dispensed are within the specified limits for the test.
- Ensure that the condom is secured on the mount in such a way as to avoid slippage during water dispensation, especially for the condoms that need volumes of more than 300 mm.
- The condom may be tapped gently to remove air bubbles present on the inner surface of the condom.
- It is essential that the rolling is carried out correctly. The water-filled condom must be rolled for a distance sufficient to allow the whole surface of the condom to contact the paper. This distance is frequently underestimated. When training operators it can be helpful to mark the condom to show how far the condom must be rolled. The condom must be rolled through at least two complete revolutions (but not more than ten).
- Ensure that the correct amount of pressure is applied to the condom. The hand (with fingers spread) should be maintained 25 to 35 mm. above the paper.
- When testing the closed end of the condom, maintain a similar level of pressure as when rolling, and do not slide the condom over the paper.
- The coloured absorbent paper should be one that makes it easy to identify the blots made by the presence of holes on the condom wall. It should also allow for the rolling of the condom body for the required revolutions as per ISO 4074. Under no circumstances shall multiple absorbent papers be joined using sticky tape.
- The condom walls may be carefully wiped with soft absorbent cloth or paper to remove excess moisture and lubricant thus allowing for easier detection of leaks.

B. The Electrical Test
Points to note:

- The equipment shall be routinely calibrated or verified for effectiveness, and maintained as per manufacturer’s specifications. This includes routine changing of the electrolyte solution as build-up of lubricant may affect the efficacy of the test.
- The different parameters that affect the test, such as voltage, should be checked before each batch/lot test, using calibrated apparatus, for conformity to specified limits.
- Not more than 25 mm of the condom should be left unexposed to the electrolyte.
- Any leaks detected by the system should always be confirmed by the rolling method done in the Water Leak Test. Note that ISO 4074:2015 specifies the Hang and Roll method must be used - not the ASTM D3492 Hang and Squeeze method.
- Note that the condoms have to be observed during filling in order to detect any holes (see M 3.3.7 third line)

7.2 ASTM D3492 – 15, Annex A3

A. The Water Leak Test (Hang and Squeeze)

This method is very similar to the Hang and Roll method, except that the condom is not rolled. Instead pressure is applied to the condom by gently squeezing it whilst it is hanging, full of water, on the test equipment. The test must be carried out exactly as described in the Standard.

Points to note when using this method are:

- After filling with water, the body of the condom should be tapped gently to dispel any air bubbles present on the inner surface of the condom.
- Do not apply too much pressure by squeezing too hard. The correct amount of distension of the filled condom is shown in figures A3.3 to A3.5 in the Standard.
- When checking the body of the condom, gently rotate the condom so that the entire surface is inspected.
- When examining the condoms for signs of leakage, ensure that any water droplets on the outside of the condom are the result of leakage, and not water splashed onto the condom from any external source. If necessary, gently dry
the outside of the condom with a paper towel and re-check.

8 Visibly Open Seals (ISO 4074:2015, Annex N)

This test is performed using samples which are drawn for conducting the test for Freedom from Holes and visible defects.

The individual sealed containers are examined by visual observation for any visibly open seal defects which include improperly formed seals, condoms getting trapped in sealing area, uneven or very narrow sealing edges leading to open seals and leakages. It is recommended that the test laboratory has the display of defects related to visibly open seals to serve as examples of workmanship criteria so that consistency is maintained in conducting the test. The defectives observed should be preserved for reference.


The test for visible defects is conducted on the same set of samples taken for the test for Freedom from Holes.

After performing the test for visibly open seals, the individual sealed containers are opened by pushing the condoms to one side of pack and opening the seals, taking care that the condom is not damaged by the rough edges of the seals, nor sharp instruments such as scissors, or finger nails. The condoms are unrolled and examined by visual observation under bright light. It should be ensured that all the parts of the condoms are completely covered by the visual observation. The visual defects are classified as Critical and Noncritical defects with corresponding AQLs of 0.4 and 2.5. The section on Workmanship and Visible defects on the WHO/UNFPA Specification details the list of Critical and Noncritical defects. This section also lists the minor imperfections, which do not affect the properties of the condoms, but are considered as potential points for elimination with appropriate quality improvement projects. Personnel should be trained for the ability to detect the visible defects and to correctly classify them. Having an approved workmanship criteria album will be useful to avoid any disputes.
10 Determination of Package Seal Integrity (ISO 4074:2015, Annex N)

The seal on the individual condom container, whether of the standard foil pack or the “butter dish” container can, at times, be compromised. This can be caused by several factors, including misaligned sealing jaws, excessive lubricant, a misaligned or poorly rolled condom being trapped in the seal, etc. In addition, the foil may contain pinholes or, if the information on the foil is stamped on, rather than ink-jet printed, the stamping may damage the foil. All in all there are many ways in which the individual condom container can contain small holes. A consequence of this is that lubricant can leak out, and if not detected, can contaminate all the other condom containers within the same pack. In addition, a compromised foil can expose the condom to oxygen, which could cause premature degradation. For this reason it is necessary to test the integrity of the packages.

There are other tests under development, which may in time replace this method, but for the moment the test described in Annex N of ISO 4074:2015 is the one to be used.

Points to note:

● Working with a vacuum is potentially dangerous. Eye protection should be used when carrying out this test.
● The vacuum chamber should be closable with an air tight transparent lid so that the defective packs can be easily observed during the test.
● A vacuum level of 20 ± 5 kPa absolute must be used. That is approximately 20% of normal atmospheric pressure at sea level. Unfortunately some gauges will read from 0 to 100 kPa, whilst others may read from 100 (or -100) to 0 kPa (see figure 3). This can be confusing. If the gauge reads from 0 to 100, the correct level of vacuum will be the figure of 20 kPa: if the gauge reads the other way, the correct vacuum level will be 80 (or -80) kPa (figure 3). In case of doubt remember that it is the greater level of vacuum that must be used. It will typically take at least 20 seconds - often considerably longer - for a vacuum pump to evacuate the chamber to this level. Changes in the time taken to reach the desired vacuum level can be indicative of complications in the test system or an inaccurate level of vacuum being used.
● The water level should be such that the condom packages are at least 25 mm. below the surface.
● The number of packages in the chamber should be restricted, so that all the
packages can be clearly observed.

- A dye is often used to help detect leakage into the containers, and the amount used should not obscure observation of the packages.
- If a dye is used, it should be easily washable and should not leave any deposit of colour building up, as that would obstruct the observation of leakages. The vacuum container and the lid should be maintained clean.
- Using a low concentration of a low foam wetting agent (for example a non-ionic surfactant) will help wet the outer surface of the individual condom containers and reduce the possibility of bubbles caused by air clinging to the foil.
- Observe the condom packages as soon as the vacuum pump starts - don’t wait until the specified vacuum level has been reached to start the observation. By that time all the air in a defective package may have been expelled, and the stream of bubbles will have ceased.
- All of the individual containers must be opened to check for the presence of water inside. This is where the dye can be helpful, to distinguish between lubricant and any water that may have entered the pack.
- Vacuum pumps working off compressed air can be a more cost-effective option than a mechanical vacuum pump.
Figure 3. A pressure gauge reading from -100 to 0 kPa. In this case the correct vacuum level for the test would be -80 kPa (red numerals).