

A guide to the ultrasonic cleaning process for healthcare professionals in primary care dental practices

Ultrasonic cleaners are recommended in HTMo1-05 and by many instrument manufacturers as being the most effective way to clean surgical instruments, particularly those with hinges or other moving or intricate parts. They are far more effective than even the latest washer/disinfectors. This is because an ultrasonic cleaner has the ability to remove contaminants from crevices, joints and other difficult to access areas of dental and medical instruments.

Recent documents such as HTMo1-05 and BDA Advice sheet A12 detail ultrasonic cleaners as 'an option' within the surgery but also state that evidence exists on their effectiveness in dentistry, especially where hinged instruments and/or intricate parts are concerned. If an ultrasonic cleaner is the most effective device for removing contaminations in these situations why is their use only optional in these documents? Surely ALL health care professionals are striving for best practice and therefore want to reduce the risk of cross infection to an absolute minimum?

There are still many misconceptions about ultrasonic cleaners and their use, for example The Glennie Report found that 92% of dental surgeries have an ultrasonic cleaner, however 96% of surgeries never check the efficiency.

In the medical field, thorough cleaning of instruments prior to sterilisation is essential. If an instrument is not properly cleaned and rinsed it subsequently may not be properly sterilised.

What is ultrasonic cleaning?

The audible frequency range of the human ear is from about 16 Hertz (16 Hz) to 16 Kilohertz (16 kHz), Middle C is 216 Hertz, a grasshopper call around 7 kHz and a bat signal about 70 kHz. Beyond human audible range is called 'Ultrasonic'. Most ultrasonic cleaners operate in the range of 30 to 60 kHz; ours have an operating frequency of 45 to 55 kHz.

Ultrasonic cleaners function by producing sound waves that are transmitted into the tank and cleaning solution. These waves create millions of microscopic bubbles, which collapse or 'implode', releasing large amounts of energy, which scrub the surface clean. This process is called 'Cavitation'.

This Cavitation dislodges contamination from the surface of instruments and in joints and crevices that are unreachable by any other method. Once removed the contamination is held in the cleaning solution.

A 'generator' located within the ultrasonic cleaner develops the high frequency power. This supplies the power to the 'transducer' - a Piezo ceramic disk that is bonded to the base of the tank. The transducer creates the high frequency sound waves in the tank by turning the electrical energy into mechanical energy.

The effectiveness of the ultrasonic cleaning process can be affected by many factors:

- The power of the ultrasonic bath itself
- The type and age of contamination
- The temperature and chemical consistency of the cleaning solution
- The amount of gas dissolved in that solution
- The length of time an item is cleaned
- The quantity and configuration of the instruments being cleaned

Failure to assess each one of the above points will reduce the end cleaning result. For example the best ultrasonic cleaner will not effectively clean instruments if the solution is not degassed or an incorrect solution is used.

We will examine each of the above 6 points in detail.

Section 1 : Bath power

Whilst the power of an ultrasonic bath may depend on points 3 and 4, manufacturers will generally quote a power figure as an average power output, peak power output or power consumption. In the main, the peak output figure will be 10 to 100 watts per litre. The higher the watts per litre figure, the quicker and more efficiently the unit will clean.

Section 2 : Type of contamination

As this article is mainly designed to educate Dental Surgeons and DSA's, we will concentrate on that area. In dentistry and oral operations saliva may be present. This can easily be removed with a general purpose cleaning solution. It is best if the Decontamination Holding Time (DHT) is kept to a minimum as dried contamination, no matter what, is harder to remove than 'fresh' contamination.

There is little evidence that pre-soaking of instruments prior to cleaning will enhance the removal of debris. Pre-soaking in an enzymatic cleaning solution could theoretically help, however studies suggest that there is no benefit.

IMMEDIATELY after the medical procedure, instruments should be rinsed and then placed in the basket in the ultrasonic cleaner containing a cleaning solution. The cleaning cycle should then be initiated as soon as possible. The rinsing stage is paramount, as much of the surface contamination will be flushed away thus avoiding unnecessary contamination of the cleaning solution.

The DHT is particularly important where blood contaminations are present. 'Fresh' or 'wet' blood is easily removed whereas dried blood is not. This is firstly because blood contains haemoglobin that becomes insoluble when dried. Secondly, fibrin, a fibrous protein that is built up during coagulation is also insoluble. These proteins easily adhere to the surfaces of surgical instruments making them difficult to remove even with the aid of chemical cleaning agents.

The type of contamination and cleaning solution used go hand in hand. A hydrocarbon based cleaning solution will not remove a water-based contamination effectively; just as oil based contaminants are not easily removed with water. In order for the contamination to be effectively removed, the solution must be capable of dissolving or softening it. An ultrasonic cleaner, no matter how powerful, will NOT remove contamination from items unless the solution is suitable for removing that particular type of contaminant.

One of the most effective methods for the removal of bodily solutions from instruments is an enzymatic cleaning solution. These are described in the next section.

Shreds of dentine and other organic matter is best done by rinsing prior to ultrasonic cleaning, however, these dried on contaminants are more easily removed by an ultrasonic cleaner than blood.

Contamination by Prions is a different matter. Many things are currently known about Prions and their links to certain diseases although research is an on-going process.

A Prion is a misshapen form of a protein that occurs naturally in the body. They are not easily killed by normal cleaning and sterilisation methods. Prions have been implicated in a number of diseases including bovine spongiform encephalopathy in cattle (BSE, also known as "mad cow disease") and Creutzfeldt-Jacob disease (CJD) in humans, so obviously their removal from instruments is paramount.

Whilst it is not known how many people are actually carrying the disease it is not thought to be a large percentage of the population and therefore whilst the risk is present, it should be assessed in a logical and not hysterical manner.

A scientific study has proven washer-disinfectors can leave unacceptable levels of proteins on hospital instruments. Prions could be present in these proteins and so cause a cross-contamination risk, therefore the more proteins that are removed from instruments, the less the risk of cross contamination. To some extent this may be because washer disinfectors are not as effective at removing protein contamination from hinged joints and crevice. A washer disinfectant may also finish with a high temperature rinse. As discussed in the next section, subjecting proteins to temperatures greater than 38°C significantly increases the risk of them coagulating and adhering to the surface of the instruments leading to difficult and poor sterilisation.

Ultrasonic cleaning solutions are available that will de-activate Prions. The author suggests that combining these with an ultrasonic cleaning cycle prior to sterilisation is the best method to remove Prions. If the solution is NOT capable of de-activation Prions, changing the solution regularly will greatly reduce the risk of prion cross contamination.

HTM01-05 states that 'a low level of Prion contamination may theoretically be present on some instruments following contact with dental tissue.' It is, again the opinion of the author that the risk is realistic rather than theoretical; however the scale of risk is agreed as low (in general dentistry). The potential for cross contamination should therefore be assessed before implementing any procedure to counteract prion transmission.

Section 3 : Cleaning solution and temperature

Many different types of cleaning solution are currently available and to a certain extent each has its pro's and con's as their chemical composition usually restricts the number of types of contaminants they can remove and/or kill.

The main purpose of the cleaning solution is to soften then break down the bond between the contamination and the instrument. The use of a cleaning solution is essential, as water alone has no cleaning ability.

The cleaning solution may also have properties such as a disinfectant or cold sterilization capability.

Solutions on the market contain a variety of ingredients and are designed to optimise the cleaning process. The ability to reduce surface tension is one of the most important factors, as an ultrasonic cleaner will not function properly when the solution surface tension is high. The solution will normally also contain a surfactant or wetting agent. Low foaming detergents are mostly advised although not essential.

When choosing an ultrasonic cleaning solution the following should be considered:

- The type of contamination to be removed and/or de-activated
- The type of instrument to be cleaned
- The instrument manufacturer's recommendation
- The compatibility with ultrasonic cleaners
- The environmental impact and subsequent disposal of the contaminated solution

Always choose a cleaning solution based on the above criteria and follow the instructions given by the manufacturer.

Enzyme or Enzymatic cleaning solutions are a common and effective way of cleaning a wide range of medical contaminants. Enzymes are proteins that are naturally produced by all living organisms. This makes them a biodegradable and non-toxic alternative to some chemical cleaners. Enzymatic cleaners function by attacking the contamination and breaking down the bond between it and the instrument so it can be easily removed by the ultrasonic cleaner.

There are several different types of enzymes, each of which works on different types of stains. Proteases are a type of enzyme that works on protein-based stains, while lipolases work on lipids or fats, and amylases break down carbohydrates and starches. Proteases or Proteolytic enzymes are the most common used in medical ultrasonic cleaning formulations, as the contamination being removed is predominantly protein based.

With any cleaning solution, care should be taken that the temperature is kept below 38°C, as higher temperatures may potentially strengthen the bond between the contamination (protein) and the surface making it harder to remove. Different enzymes work at different temperatures but normally within the range of 20°C to 70°C.

Solution temperatures below approximately 20°C should be avoided as Cavitation is reduced at lower temperatures as surface tension is increased.

At the end of the day, no matter what type of cleaning solution is used, the ultrasonic cleaner should be emptied, cleaned and left to dry.

Section 4 : Dissolved Gas in ultrasonic cleaning solutions

Degassing is the process of releasing air bubbles that are dissolved or trapped in tap water when a cleaning solution is diluted. Tap water normally has a quantity of dissolved air in it, often because the water is passed through fine metal gauze in order to introduce air for aesthetic and controllability purposes. Air may also enter the water system due to pressure changes and through burst pipes.

This dissolved gas has a 'cushioning' effect on the ultrasonic waves, reducing the power and therefore the effectiveness of the ultrasonic cleaner.

Each time the cleaning solution is changed a degassing cycle should be carried out. In certain circumstances degassing may be required if the cleaning solution has been left in the tank for some time.

Degas the solution as follows:

Fill the bath with water and cleaning solution and activate the ultrasonic cleaner.

It is essential to use a cleaning solution as an ultrasonic cleaner will struggle to degas water alone as the surface tension is often too great.

After activating the ultrasonic cleaner, you will see a cloud of minute white 'foam' rise to the surface, which may also be accompanied by larger bubbles that rise to the surface. There may also be bubbles that seem suspended in the solution.

Degassing has now started.

The time taken to complete a degassing cycle depends on several factors such as the water temperature and quality, type of cleaning solution used, the size of the tank and even the frequency of the ultrasonic, however, the cycle is complete when the tone of the cleaner changes or gets louder and the 'cold boiling' action of the solution within the tank increases.

When this occurs the solution has been degassed. The unit may be turned off and a normal cleaning cycle started.

Once the cleaning solution has been degassed, avoid stirring or unnecessarily agitating the solution as this may introduce air again.

An automatic degassing cycle may be incorporated in an ultrasonic cleaner. Ideally these with 'pulse' giving a period of ultrasonic activity interlaced with an off period. This is generally quicker and more effective than constant ultrasonic energy as the rest period give the trapped gas time to rise to the surface of the solution and dissipate into the air.

Section 5 : Time to clean an item.

Cleaning time is probably the most common factor in ultrasonic cleaning to get wrong!

Cleaning times of instruments vary greatly depending on several variables:

- The type and amount of contamination
- The type of cleaning solution used
- The temperature of the cleaning solution
- The number and location of instruments being cleaned
- The contamination within the cleaning solution

The 1st three items have been covered in section 2 and 3. Item 4 is fully covered in section 6.

Many ultrasonic cleaners are fitted with a variable timer. This is essential as it will allow the users to adjust the time depending on the assessed factors.

Manufacturers of ultrasonic cleaners rarely quote a time for their ultrasonic cleaners to perform a full cycle. This is left to the operator to assess and adjust as required.

Several companies suggest a 6-minute cycle, which would seem to be a good starting point. This may be 'too long' depending on the power of the bath. By too long, we mean that a shorter time may clean the instruments to the same level of cleanliness – you cannot 'over clean' an instrument, although it is possible to cause damage if the ultrasonic exposure time is excessive.

After a 6-minute cycle has been completed remove the instruments and visually inspect each using a magnifying device. Pay particular attention to any hinged or recessed areas as these pose the most difficult challenge to the ultrasonic cleaner. If the instrument is not clean, reload the basket, place back into the ultrasonic cleaner and initiate another 6-minute cycle.

Should the ultrasonic cleaner not have cleaned the instruments within 3 cycles AND the user is satisfied that points 1 to 6 have been complied with, there may be a fault with the unit. See section 7 (miscellaneous information) for information on how to check the efficiency of the ultrasonic cleaner.

If the user is in doubt about the cleanliness of the items, a kit is available to swab and test for the presence of any non-visual proteins. The suspect item is simply wiped with the swab and the results compared with a colour chart. Some Protein Residue Tests require incubation to attain a high level of accuracy, other can achieve a similar or even greater accuracy without incubation. Results can be achieved in as little as 10 seconds with some protein residue tests.

Another important point is to thoroughly rinse the instruments after cleaning. Whilst ultrasonic cleaning will remove the contaminants from the surface of the instruments they can be re-deposited on removal from the tank. As well as the potential for the re-depositing of contamination, cleaning solution will also be left on the instruments. Cleaning solutions must be removed before the instruments are processed further as they can damage sterilisation equipment such as autoclaves.

It is advisable to rinse the instruments in a sink/container with clean water as opposed to under running water. This is due to the potential for aerosol production containing contaminants.

Instruments should be sterilized as soon as possible after they have been cleaned. Avoid air-drying as this can result in air borne contamination, corrosion and/or bacterial growth.

Addressing point 5. The cleaning solution should be changed on a regular basis. If the solution appears contaminated it may not perform as it should. Thorough pre-rinsing of the instruments prior to cleaning will assist in the reduction of contaminants being introduced into the solution however, it will obviously not stop it completely.

HTM0105 recommends changing the cleaning fluid **at least** every 4 hours and more often if visibly contaminated.

The individual solution purchased may state the time it will be active for; for example most enzymatic cleaning solutions will only remain effective for 24 hours and this time should be strictly adhered to.

Section 6 : The number and location of the instruments being cleaned

The number of instruments that are cleaned at once should be limited. Each instrument must be placed in the basket and separated in order to:

- ensure that ultrasonic energy is able to easily access all surfaces
- to avoid any electrolytic action between different metals.

The instruments should not be stacked on top of each other as the centre ones may be 'masked' from the ultrasonic energy and therefore not efficiently cleaned. The basket or tray should then be correctly located in the bath.

Attention should be paid to any special recommendations made by the manufacturer of the ultrasonic cleaner and the instruments being cleaned.

Section 7 : Miscellaneous information regarding the use of ultrasonic cleaners

Testing of ultrasonic activity and validation.

HTM 01-05 gives information on the validation and verification of ultrasonic cleaners and details the daily, weekly, quarterly and yearly testing protocols.

It specifies the foil ablation test as a means of determining the efficiency of the ultrasonic bath and advises it should be carried out Quarterly. The test is performed by suspending strips of aluminum foil throughout the tank and operating a normal cycle. On removal from the tank, the strips should show uniform signs of erosion. Interpreting the results of the foil test can be difficult, as different ultrasonic cleaners will produce different patterns of erosion, all of which could be deemed as a 'pass'. Variations in cleaning solution levels and temperature and type of cleaning solution can also affect the results.

The foil ablation test is designed to indicate 'hot' and 'cold' spots of ultrasonic activity within the tank as well as the ability to clean. 'Hot' spots are points within the cleaning solution where ultrasonic activity is concentrated. 'Cold' spots are areas within the cleaning solution where there is a lack of ultrasonic activity. In theory these occur, however, as the frequency of an ultrasonic tank varies due to water temperature, level, moving of the parts being cleaned and many other factors, in practice their effect on the cleaning process is minimal if the ultrasonic cleaner is functioning correctly.

In a tank with a single transducer the foil test indicates 'hot' and 'cold' spots and to a limited degree, cleaning ability, however, in a multi transducer tank it can indicate a problem with one or more of the transducers. For example, if one transducer on a 4 transducer ultrasonic cleaner is only working at 50% the ultrasonic cleaners overall performance will be reduced by 12.5%, however in a single transducer tank, a similar fault will result in the cleaner only performing to 50% of its ability. There would obviously be a noticeable difference in the foil test strips on the four transducer tank but not in the one transducer tank. The fault in the one-transducer tank could be picked up by comparing the result with a result taken when the machine was commissioned, whereas a similar fault in the four-transducer tank could be picked up by examination of the foil strips alone.

Please refer to document HTM 01-05 for further information on the foil ablation test.



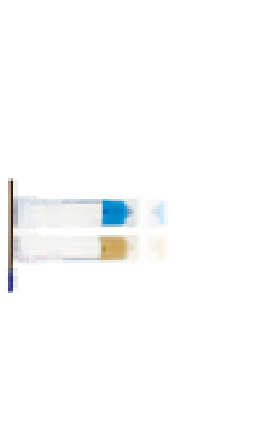



Another method for testing the efficiency of cleaning of the tank is to use a load test strip. HTM 01-05 suggests this test is carried out quarterly, however different manufacturers may suggest this as a weekly test. The load test strips are plastic strips that have been printed with special proteins and are designed to perform in a similar manner to the test soil described in documents such as HTM01-05. They are an excellent indicator of ultrasonic cleaning performance as they present a realistic challenge to the ultrasonic cleaner. The strip is placed in a holder that is then placed in the tank. The tank should contain de-gassed solution with your normal cleaning solution. A normal cycle is then performed. After one complete cycle (determined by reading section 5) the holder is removed and the strip examined. Should more than 2% of the soil remain the ultrasonic cleaner must be withdrawn from service and its performance assessed by a qualified person or the manufacturer.

On a multi transducer tank both the foil ablation test and the soil test will provide a different, but accurate assessment of the ultrasonic cleaners' ability to clean. On a single transducer tank it is the authors' opinion that either a load test or foil ablation test alone will determine the efficiency of cleaning of the ultrasonic cleaner, as any fault will produce a result which is standard throughout the tank. Both test results could also be compared to the result obtained when commissioning the ultrasonic cleaner.

There are various other methods for testing the efficiency of your ultrasonic such as paint on soil tests, the pencil load test and various ultrasonic activity meters.

Wand meters or activity meters are mentioned in HTM 01-05, however they should be used with care, as the results are not reproducible as exact positioning of the probe is impossible. The activity meter tested by Walker Electronics Ltd did not give a meaningful reading as the power was represented in a 0 to 100% format with no explanation of what 100% was. The frequency that the activity meter stated was also suspect as the calibrated external frequency counter connected to the circuit was producing a different. For these reasons I would not recommend their use.

The ultrasonic cleaner should be tested in line with HTM01-05 as in the following table:

HTM0105 & Walker Electronics Ltd recommend the following testing protocol				
	Walker Electronics Model QC and Q105 Ultrasonic Bath	Walker Electronics Model 80T and 80H Ultrasonic Bath	Other Manufacturer Ultrasonic bath	
Daily	Visual inspection of instruments	Visual inspection of instruments	Visual inspection of instruments	
Weekly				
Quarterly				
Yearly	Return to Walker Electronics Ltd for validation	Return to Walker Electronics Ltd for validation	Return to equipment manufacturer for validation	

Key to tests in HTM0105 as described in section 7



The protein residue test is used to detect residual protein on instruments after they have been cleaned AND rinsed. Instruments **MUST** be rinsed prior to testing as cleaning fluid residue can interfere with the result. It involves swabbing an instrument and placing the swab in a vial containing a chemical and noting any colour change. Some Protein Residue Tests require incubation to attain a high level of accuracy; others can achieve a similar or even greater accuracy without incubation. Results can be achieved in as little as 10 seconds. If proteins are detected on instruments this means that they are **NOT** clean and therefore **NOT** suitable for sterilization. Any protein detected on instruments indicates a problem with the cleaning or rinsing process. This may be caused by the ultrasonic cleaner, cleaning fluid or both. This test is suitable for use with manual cleaning, ultrasonic cleaning and washer disinfectors.



The soil test (different soil test to the pictured are available). Used to verify that the ultrasonic cleaner or washer disinfectant is capable of removing an artificial soil. In the picture to the left, the plastic strip which is printed with a special protein 'ink' is placed in the stainless steel holder. This is then placed in the ultrasonic bath with cleaning fluid, a normal cycle completed and the result noted. If the soil is **NOT** removed from the test strip this indicates a problem with the cleaning process. Again, this may be faulty equipment, ineffective cleaning fluid or both.



Test Foil. Used to perform the foil ablation test as described in detail in HTM0105 and section 7 of this document. The foil must be of a consistent grade and quality therefore **ONLY** foil specifically manufactured and supplied for testing ultrasonic cleaners should be used (as stated in HTM0105 section 15).

Whilst validation is a required part of HTM01-05, the user can easily 'validate' every batch of ultrasonically cleaned instruments. If an instrument looks soiled after cleaning, it probably is. If the ultrasonic cleaner is not producing the same patterns in the water or sounds that it did when it was new, maybe it is faulty. These are two very simple and vastly underrated validation tests that the user should carry out each time the ultrasonic cleaner is used!

The human element!

Another important factor in the ultrasonic cleaning process is the human element. It is essential that all staff using an ultrasonic cleaner are aware of its functionality and correct operating procedures. Such knowledge is paramount to ensuring that instruments passed through the ultrasonic cleaning cycle emerge as clean as possible and fit for sterilisation.

Ideally staff should read the ultrasonic cleaners operator handbook to familiarise themselves with its operation and features. If there are any subsequent questions these should be raised with the manufacturer.

Many other documents such as HTM01-05, BDA Advice sheet A12 and other publications by the Department of Health, The BDA and National Dental Advisory Committee will all provide useful additional information.

HTM0105 and Features of Ultrasonic Cleaners – 2 common misconceptions

Section 10.21 and 10.22 of HTM0105 state the features that should be considered when purchasing an ultrasonic cleaner. In the main, these features will decrease the possibility of poor cleaning; however there is a lot of confusion regarding these suggested features.

“I have been told that my ultrasonic cleaner MUST have a locking lid”

Incorrect. It is suggested that the ultrasonic cleaner should have ‘a hinged auto-locking lid that prevents interaction with the load once the ultrasonic equipment is in use, also reducing the risk of aerosols and noise...’ but then goes on to state ‘if not interlocked, the equipment should be clearly labelled, warning users not to put their hands in the device when activated’!

There are several things that are questionable in that statement.

An interlock is a device that prevents an undesirable condition occurring in equipment – this is not the same as a lock. It is the authors’ opinion that if the ultrasonic cleaner has a device which stops the ultrasonic cleaner and fails the cycle if the lid is removed this is far better than a label which can be ignored. A locking lid which prevents is not ideal either as it restricts access to the instruments in case of power failure and/or situations where instruments just need to be removed!

The statement also begs the question ‘Why do we need a locking lid?’ Is it to prevent access to the instruments? Is it to protect the user from placing their hand in a working ultrasonic cleaner? Is it noise or aerosol reduction?

“Why doesn’t ultrasonic cleaner doesn’t have a drain tap?”

HTM0105 suggests that the ultrasonic cleaner should have ‘a reservoir drainage facility that does not affect performance and does not leave pools of fluid in the reservoir, which allows the tank to be emptied without the need for operatives to put their hands in the fluid;’

Speaking as the Managing Director of Walker Electronics Limited, for many years we have NOT manufactured an ultrasonic cleaner with a drainage facility. This is because:

- Ultrasonic energy tends to target imperfections/weaknesses in the tank especially welds and push fit connectors. Leaking of drain taps is a common occurrence and can result in dangerous situations with water and electronics and can lead to the unit being un-repairable.
- The drain tube cannot be easily cleaned. I have visited many surgeries with a variety of ultrasonic cleaners installed in them. I am continuously amazed by the contamination that can clearly be seen in these tubes which immediately contaminates any fresh solution put in the machine. Whilst I can understand the issue of lifting of larger machines, I cannot understand why HTM0105 recommends these as they obviously pose a huge cross contamination risk.

Some of the do's and don't of ultrasonic cleaning

Some of the information below is repeated from the above section. This is done to re-enforce the correct manner in which to use your ultrasonic cleaner.

DO use the correct solution for your application. DO NOT use water alone in the tank when operating the unit as a wetting agent is required for correct transference of ultrasonic energy. Ensure that the correct dilution is used – a stronger solution than recommended by the manufacturer may give equally poor results as a weak one.

DO keep the lid on during use and at all other times when feasible. This will prevent the emission of excess noise and aerosol production.

DO ensure that the level of the solution is within the range recommended by the manufacturer, as incorrect levels can be detrimental to the cleaning process.

DO ensure that you have a SDS (safety data sheet) for the chemical you are using on file and that all staff are aware of the action to take in case of spillage or human contact.

DO NOT operate the unit without solution in the tank.

DO NOT drop the unit or experience it to shock or impact and do not drop items directly onto the base of the tank as this may damage the transducers. Pouring very hot or boiling water into the tank could also cause damage the unit.

DO NOT use acid, bleach or any corrosive substance in the stainless steel tank, as they may attack the metal.

DO NOT place your hands in the solution while the unit is operating.

DO keep the front panel dry. NEVER allow solution to run down the unit case or around the cable inlet area.

DO NOT operate any switches when your hands are wet.

After long periods of operation, the top of the tank and solution may get warm. This is quite normal and is caused by the ultrasonic energy travelling up the sides of the tank and hitting the rim and causing an 'ultrasonic heating' effect.

DO NOT move the unit whilst in use or connected to the mains supply in order to avoid spillage or overflow.

It is advised by some manufacturers that during operation the minimum distance between any person and the equipment is not less than 1 metre. This is due to 'ultrasonic pressure' that radiates from the machine which it is believed can be detrimental to human health.

The author, Brian J Everitt, Managing Director of Walker Electronics Ltd has been working in the ultrasonic cleaning industry for the past 27 years. This article is based on his industrial knowledge and experience. No guarantee is given with respect to the accuracy of this article. This writing of this article is an ongoing process and is adapted as current thinking and standards are changed. For this reason it may not be totally up to date; however it is believed to be correct as of the last review date April 2013. E&OE.