VIRKON
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INTRODUCTION

This document sets out to provide in a logical order all the information required by a sales-man in order to clinch the sale for VIRKON.

It poses (and answers) the 4 key questions which form the basis of all sales calls:-

a) Why disinfectants are needed

b) How the disinfectants currently available fail to meet the needs of modern infection control

c) Why VIRKON was designed in the way it was

d) How you can prove to the user that VIRKON meets all his requirements

- efficacy
- spectrum
- safety and protection
- convenience
- range of uses
- cost-effectiveness

(*Spectrum* = range of micro-organisms which an agent can kill.)

THE NEED FOR DISINFECTION

The Advance of Modern Healthcare

Modern healthcare and public health continue to advance at a breath-taking rate

- life expectancy is increasing in virtually every society
- diseases have been eliminated, e.g. smallpox, and new therapies are available for illnesses which only a few years ago were regarded as killers, e.g. heart-bypass surgery

The Scale of Infectious Disease

Yet infectious diseases still present a enormous threat to all of us and form a huge drain on financial resources

- the projected figures for AIDS worldwide show no sign of slowing
- many diseases regarded as minor or easily treatable in affluent societies are large-scale killers in regions where nutrition is poor and medical provisions lacking
  e.g. measles and TB kill 2.3 and 2.6 million people per year respectively worldwide
- the very act of entering a hospital as a patient in order to benefit from modern medicine carries a risk, e.g. in the UK (where infection control is well-established) 11% of all patients entering hospital develop an infection

Changes in society and behaviour lead to increases of some diseases

- the massive increase in travel means that what were once localised outbreaks of disease now take on worldwide proportions
- changes in sexual behaviour and the increased use of injected drugs have fuelled the upturn in AIDS and Hepatitis B figures
- the adoption of new food processing and preparation techniques can lead to increased food poisoning if end users are not properly taught the new techniques

Infection Control Measures

Having painted a picture of gloom and convinced ourselves that infection lurks around every corner, let us look at how we prevent infections and their spread. This divides into two main approaches, preventing people catching an infection and curing the

infection so that it cannot be passed on to others. Both of these approaches are further subdivided:-

1. Preventative measures

- isolation
- barrier (physical) methods
- prophylaxis
- vaccination (defined later)

2. Curing the infection

- antimicrobial treatment

Looking at these approaches in further detail:-

1. **Preventative measures**

In other words, preventing people catching the disease or passing it on -

a) Isolation

Clearly, if people carrying infectious diseases could be kept apart from healthy people then the spread of infectious diseases would be greatly reduced. However, this is not practical in most cases and we must be aware that with many diseases, particularly those caused by viruses, the patient is most infectious in the few days before the first symptoms occur (the pro-dromal period)

b) Physical (barrier) methods

In any situation where diseases could be caught or passed on, it is important to erect physical barriers to microbes

e.g. the most widely used are gloves, gowns and masks. In a laboratory situation their aim is to protect the worker from the microbes present in samples.

In a high-tech food factory, the aim would be the opposite in that they prevent microbes travelling from the worker and contaminating the food.

Condoms are a very effective barrier device in the prevention of sexually transmitted diseases.

c) Prophylaxis

Malaria is common in many parts of the world and could be a threat to travellers. A vaccine does not exist for malaria but effective treatment is available, e.g. quinine. It has been found that if a traveller takes quinine during his trip and for the period following it then the malaria parasite is unable to infect him successfully. This method of taking the treatment

before being exposed to the infection is known as prophylaxis. This method assumes that you know exactly which diseases are a threat and that effective treatments are available - this is clearly not a practical method for widespread infection control.

d) Vaccination

What happens when you get an infection? Typically you have a high temper-ature and the infected site becomes red and inflamed. These reactions are not caused by the infection but are part of the body's reaction to foreign invaders. This reaction is controlled by the body's immune system.

The immune system has two functions:

(i) to recognise invaders

All cells of your body carry proteins on their surface which your immune system recognises as part of you or "self". Foreign or invading cells have "non-self" proteins (antigens). Microbes or foreign tissue (such as a transplanted heart) are therefore recognised as foreign and marked out for attack.

(ii) to combat invaders

When the immune system identifies antigens, it causes the production of specific antibody cells which stick to that antigen and therefore mark it out for the killer cells of the immune system to attack and destroy. (Your immune system carries antibodies for every single micro-organism that you have encountered throughout your life!) The only drawback to this amazing system is that it takes time for the body to produce the antibodies required and in that time delay the disease may become so advanced that the body cannot overcome it. The aim of vaccination is to reduce the time lag in antibody production.

Principle of Vaccination

The idea of vaccination is to allow the body to produce antibodies for the first time before you encounter the disease. It does this by presenting the antigen in a safe form. Then at a later date when you are challenged by the microbe the body already has a working pool of relevant antibodies and the whole process is mounted much more quickly. Three methods of exposing the antigen exist:

a) using a chemically weakened attenuated form of the microbe which cannot cause the disease

b) using a strain of the microbe which cannot cause the disease (a non-virulent strain) but which has an almost identical antigen to the virulent strain

c) using the pure antigen (protein) itself which can be purified in the laboratory or a chemical copy of it

Drawbacks of Vaccination

a) Practicality

It is clearly not practical to vaccinate all members of a population against all diseases. Therefore vaccination is confined to the major diseases (e.g. polio) or to specific population groups at particular risk, e.g. children during a meningitis outbreak or the elderly during a flu epidemic.

b) Time scale

Vaccines cannot be developed overnight - the hepatitis B vaccines introduced in the 1980's took 20 years to develop. This means that a new disease cannot be fought in the short term by vaccination as re-inforced by HIV..

c) Mutation

Each year, a new influenza outbreak occurs and as a rule the vaccine used the year before is no longer of use. This is because micro-organisms are not static, they are continually mutating or changing leading to many strains or types of the same organism all capable of causing the disease. A vaccine developed against one strain or type of an organism may not be able to provide protection against all the other forms available. In terms of HIV, the virus which causes AIDS, many researchers feel that because there are so many forms of the virus (over 200) that there may never be an effective vaccine against AIDS.

2. Curing the disease

A key means of stopping infectious diseases in their tracks is to quickly and effec-tively treat those people who have the disease. Even this approach is not as simple as it sounds -

a) Pro-dromal phase

As we saw in the previous section, people are usually most infectious before they know they are carrying the disease (pro-dromal phase).

b) Lack of effective treatments

Effective treatments are not available for many important bacterial and fungal diseases.

c) Absence of antiviral agents

To all intents and purposes, we still have no way of curing any known viral disease. Despite 30 years of work, all we can do for the common cold is to suggest aspirin and warm drinks, i.e. leave the body to fight on its own and provide what support we can. (In fact, giving aspirin lowers the body's temperture and makes it easier for the virus to survive!!)

d) Antibiotic resistance*

The question of mutations which caused problems for vaccines also creates difficulties for the antibiotics which are used to attack bacteria. The more an antibiotic is used, the more likely it is that strains which are resistant to the antibiotic will develop.

e.g. many strains of bacteria can produce chemicals which break down the antibiotic penicillin leading to a wide range of penicillin-resistant organisms. The gross and unplanned overuse of antibiotics has led to strains of many common organisms being resistant to all of the commonly used antibiotics.

* Fully defined on page 21

DISINFECTION

Disinfection vs. Sterilisation

Definition of "STERILISATION"

Scientific definition	A process designed to kill all types of organisms with a probability that only one organism will remain from a starting count of 1,000,000,000.
Practical definition	A process which kills all organisms present, including spores.

Definition of "DISINFECTION"

Scientific definition	A process (physical or chemical) designed to give a 5 log $_{10}$* reduction of organisms (99.999% kills).
Practical definition	A process which reduces the number of organisms present to a level where they do not pose a threat to health (normally does not involve killing spores).

* $\log_{10}$ defined on page 22

Definition of "CLEANING"

Scientific definition	A process combining the physical input of energy with surfactant/detergent activity to remove organic material and associated micro-organisms.
Practical definition	Physical action with detergent giving the removal of organic material and 99-99.9% of organisms present.

Sterilization can only be reliably or repeatedly guaranteed by the use of extreme physical/ chemical methods,

e.g. placing instruments in an effective autoclave and subjecting them to high temperatures and steam pressures for extended time periods.

The range of infection control measures which include chemical disinfection run from two extremes with disinfectants occupying the middle ground -

Lowest risk		Highest risk
e.g. surfaces in the home	CHEMICAL DISINFECTION	e.g. operating theatre instruments
Regular cleaning required		Sterilization demanded

Requirements of Disinfection

As an infection control technique, disinfection has been in use ever since Lister published in the "Lancet" in 1867 of the reduction in post-operative infections when carbolic acid (the earliest phenol) was sprayed liberally in operating theatres. Hypochlorites (bleaches) have been around since the second half of the 19th century. The last new approach to disinfection (chlorhexidine) was introduced in 1949.

Opponents of VIRKON would argue that it is untried and that the existing disinfectants have all stood the test of time and proved themselves in use. As we are all aware, however, the mere fact that something has been around for years means that its use is often based on tradition or inertia rather than on logic and proof.

VIRKON only has a role if we can demonstrate that it is more relevant to the demands of modern infection control than existing products,
i.e. that VIRKON is closest to being the ideal disinfectant for the 1990's.

Properties of the Ideal Disinfectant

TOTAL PROVEN SPECTRUM	Capable of killing all disease-causing organisms.
FAST ACTING	Capable of killing in minutes.
CLEANS AND DISINFECTS IN A SINGLE OPERATION	"Contains" infection does not spread it.
SAFE FOR STAFF AND THE ENVIRONMENT	Totally non toxic to the user. No harmful vapour. Biodegradable. No effect on waste treatment plants.
SAFE FOR MATERIALS AND EQUIPMENT	Compatible with all surfaces and materials when used according to instructions.
SUITABLE FOR MULTIPLE USES	Can be used for all cleaning and disinfection tasks.
MULTIPLE USE PRODUCTS	Simplifies training. Saves inventory costs and time.

Before examining VIRKON in detail, we will first look at each of the competitors using the criteria of the ideal disinfectant as our guide.

These competitors fall into two distinct groups caused in part by the fact that traditional (i.e. old) disinfectants act by poisoning micro-organisms.

The problem is that the basic biochemical processes which are poisoned by disinfectants exist in all cells - including human ones.

Logically, therefore, the situation to date has been:

An effective disinfectant is	a)	a powerful poison
	b)	toxic
A safe disinfectant is	a)	non-poisonous
	b)	relatively poor at killing micro-organisms

The traditional disinfectant dilemma facing infection control practitioners is therefore which group to choose:

- effective but toxic
- safe but less effective

Both groups can be summarised:

	Effective but toxic		
Properties of Ideal Disinfectant	ALDEHYDES	HYPOCHLORITES (BLEACHES)	NaDCC
TOTAL PROVEN SPECTRUM	✓	✓	✓
FAST ACTING	✓	✓	✓
CLEANS AND DISINFECTS IN A SINGLE OPERATION	X	X	X
SAFE FOR STAFF & THE ENVIRONMENT	X	X	X
SAFE FOR MATERIALS & EQUIPMENT	✓	X	X
SUITABLE FOR MULTIPLE USES	X	X	X
MULTIPLE USE PRODUCTS	X	X	X

	Safe but less effective				
Properties of Ideal Disinfectant	DIGUANIDES	ALCOHOLS	SYNTHETIC PHENOLS	Q.A.C.'s	IODINE/ IODOPHORS
TOTAL PROVEN SPECTRUM	X	X	X	X	X
FAST ACTING	X	X	X	X	X
CLEANS AND DISINFECTS IN A SINGLE OPERATION	X	X	X	X	X
SAFE FOR STAFF & THE ENVIRONMENT	✓	✓	✓X	✓X	✓
SAFE FOR MATERIALS & EQUIPMENT	✓	✓	✓	✓	✓
SUITABLE FOR MULTIPLE USES	X	X	X	X	X
MULTIPLE USE PRODUCTS	X	X	X	X	X

For full information on the features and benefits of each of the above groups, please refer to the "Competitor Profiles" section at the end of this document.

VIRKON

History of Antec

Antec International Limited was formed by T.R. Auchincloss who started out as an inorganic chemist employed in the brand development of "Domestos" (still the U.K.'s leading branded hypochlorite) in the late 1940's. By the middle of the 1970's he had been the managing director of Jeyes Limited and was a board member of the giant Cadburys-Schweppes organisation. In the late 1970's, the opportunity to buy out the Jeyes animal health business was taken and after a short period the company was renamed Antec (ANimal TECnology).

In 1994, Antec stands as the U.K.'s leading developer and supplier of animal and farm disinfectant infection control products. This rapid growth is the direct result of:

a) The adoption of innovative research and development programmes for the develop-ment of new products. Antec refuses to accept that simply because products have been available long-term that they are still the products of choice.

b) A deliberative strategy of independent testing and full technical back-up

Background to VIRKON's Development

In the mid-1980's, viruses were becoming of increasing concern in both animal and human health. In animal health terms, bacteria caused the major damage but virus outbreaks were increasingly occurring which lowered the resistance of livestock to subsequent bacterial infections with huge consequences in terms of death, reduced output and greatly reduced profits. In the human health area, the fears of herpes and hepatitis B epidemics of the early 1980's were eclipsed by the geometric increase in the still untreatable HIV infection.

Clearly a major advance in disinfection was required.

Drawbacks of Existing Disinfectants

As we have seen previously even the best of the available disinfectants was far removed from the ideal. In many ways, this is not at all surprising -

a) all of the disinfectants available had been available for decades, since the last century in some cases.
None, with the possible exception of chlorhexidine, was designed for infection control. Instead, they were stumbled across or adapted from non infection control situations. It is not realistic to expect them to be able to cope with new disease challenges and infection control situations or modern materials and equipment.

b) efficacy and the ability to leave a surface looking and smelling clean were the be all and end all behind the introduction of many of these products with safety to users or the environment being of little regard.

c) all of the older disinfectants discussed have, in the main, been single chemical agents. Pharmaceutical companies spend billions of dollars each year trying to develop new antibiotics capable of killing all bacteria. It is therefore not realistic to expect a compound stumbled across decades ago to be capable of killing the massive range of viruses, bacteria, fungi and spores.

Design Requirements for VIRKON

a) the prime requirement had to be unrivalled efficacy - the ability to kill all viruses, plus the widest possible range of all other pathogens. (*Pathogens* = organisms capable of causing disease.)

b) as we have previously seen, the prime requirement would not be met by a single chemical agent, therefore a multi-component formulation would be required

c) many products have an excellent spectrum if you are prepared to allow much longer contact times than can be achieved in practice. For surface disinfection, full action in 10 minutes maximum would be the ideal.

d) a key need was for the abolition of the "disinfectant dilemma". Previously, users had to choose between effective products which had serious safety drawbacks (e.g. glutaraldehyde) and products regarded as safe but which had major gaps in their spectra (e.g. chlorhexidine). Unrivalled efficacy had to be produced by a system which offered the user protection from adverse effects as well as protection from infection.

e) we have seen the problems caused by having to pre-clean before disinfection - cleaning utensils are contaminated, adjacent surfaces are splashed, the contaminated detergent solution presents a disposal problem, staff time is doubled and cleaning materials have to be purchased (some of which can inactivate disinfectants subsequently used on the cleaned surface). The new product had to combine thorough cleaning with effective disinfection.

f) spillages of body fluids (blood, vomit, urine, in particular) are a major concern with regard to AIDS, hepatitis B, etc. Putting a liquid disinfectant on such a spillage simply spreads the contamination out. Having a powder form of the new product to absorb a hazardous spillage to aid safe disposal would be an advantage.

g) a built-in colour indicator of activity was desirable to avoid the use of test kits and to ensure that staff were not using exhausted or inactivated solutions.

VIRKON'S RESEARCH AND DEVELOPMENT PROGRAMME

Development of Formulation

The starting point for VIRKON's development was the type of organism on which infec-tion control was most acutely focused, the virus.

Below is a schematic giving the structure of the simplest form of micro-organisms, the virus. As can be seen, viruses - although the simplest form of life - are physically and chemically complex. Physically or chemically damaging the organism is not enough, organisms can repair themselves or develop resistance. In any case, it is the nucleic acid (DNA or RNA), contained within the nucleus, which determines infectivity and this must be destroyed if true infection control is to be achieved.

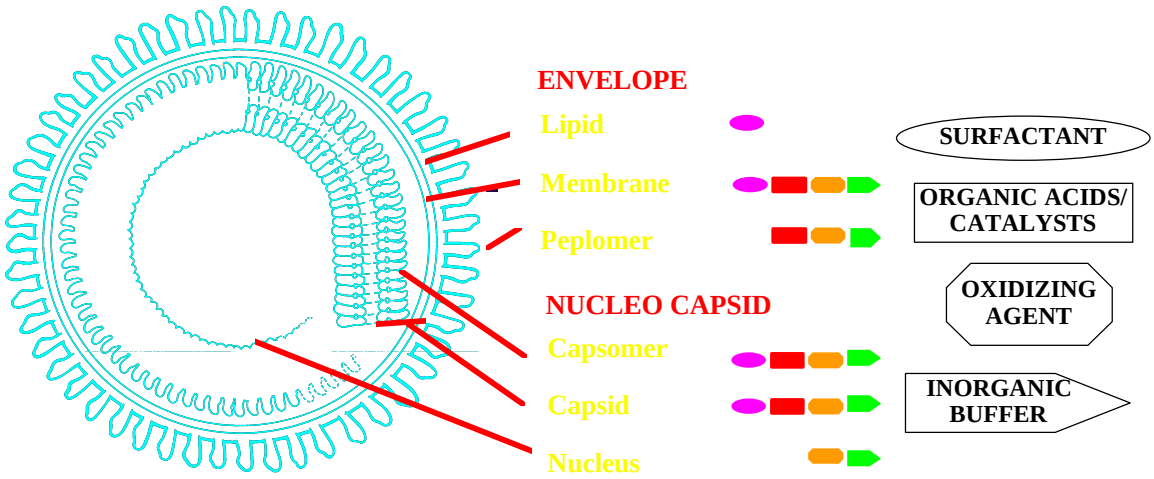
(See overleaf for graphic)

Antec's wealth of experience in disinfectant infection control indicated that an oxidising system would best be able to combine efficacy and safety. The oxidising agent chosen was the triple salt of monopotassium sulphate, which works best at low pH (i.e. under acid rather than alkaline conditions). Accordingly, two organic acids (malic and sulphamic acid) were added to produce the low pH. An inorganic buffer (sodium hexameta phosphate) was incorporated to stabilise these acid conditions. To combine cleaning and disinfection, a surfactant (sodium dodecyl benzene sulphonate) was added.

Two key requirements had to be met by all of the above components:

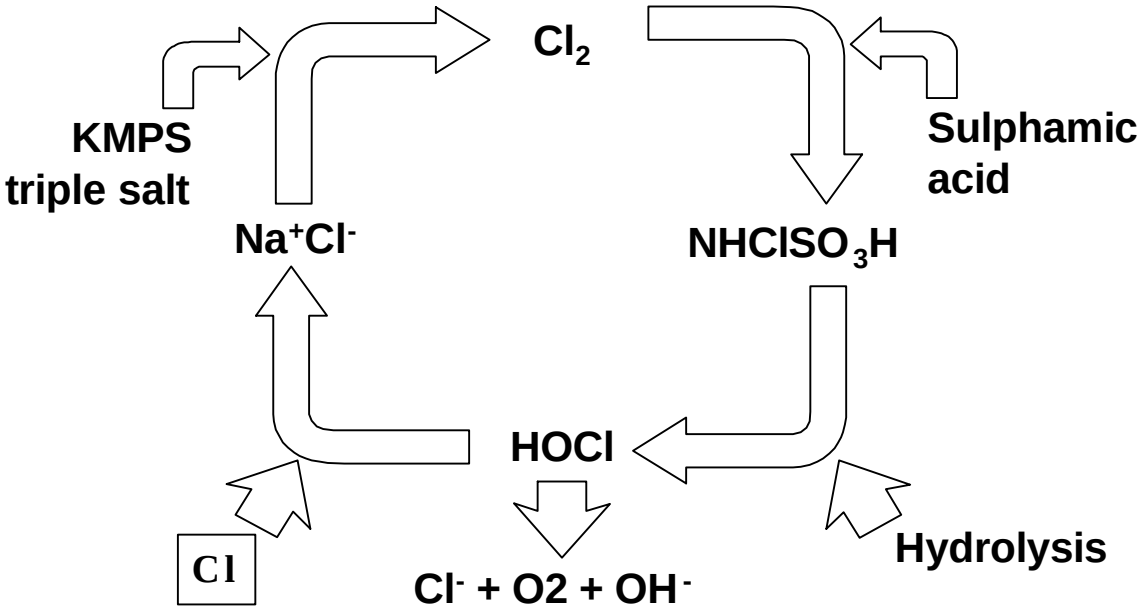
a) Safety.

b) The ability to chemically attack specific parts of the virus in their own right. Below is a schematic showing how VIRKON adopts this multiple approach to attacking the virus. Organisms can develop resistance to one chemical (e.g. Pseudomonas and chlorhexidine) - this will not occur with VIRKON. It also means that even if an organism is not particularly susceptible to the main oxidising agent, there is still a comprehensive range of biocides left in VIRKON to attack the organism. (*Biocide* = chemical able to kill micro-organisms. *Biostat* = chemical which stops them growing.)



Three further components are in VIRKON:

a) Salt (sodium chloride). This is an inherent part of the complex chemical pathway of VIRKON's action, the **Haber-Will-Statter Reaction** -



In this, the sodium chloride is oxidised (by KMPS - potassium monopersulphate). Instead of the chlorine formed being given off as a gas it interacts with the sulphamic acid (acting as a chlorine acceptor) to form an intermediary complex. This complex is hydrolised (broken down with the formation of water) to release **hypochlorous acid**. This is a powerful biocide in its own right and now becomes **the sixth biocide within VIRKON**. Please note that the reaction is cyclic - the chloride released from the sulphamic acid goes to make more sodium chloride, refuelling the cyclic system.

b) A pink dye (amaranth colour, EEC No. 123). In addition to being aesthetically pleasing, this serves a very practical purpose, - it indicates whether the VIRKON solution is active. In its oxidised form, it is pink but when the solution starts to lose its activity it reverts to its colourless reduced form. VIRKON solutions must always be replaced if the colour starts to fade.

c) Lemon peel perfume which gives the powder its characteristic odour. Note that the liquid is odourless to most people.

The above R & D process was long-term and complex involving many different formulations before the present one was adopted. In theory, VIRKON was a multi-component, optimised, oxidising system which would destroy all organisms. Other companies would have taken this product, performed tests on a handful of viruses, bacteria and fungi and launched it as “the total spectrum disinfectant/kills 100% of all pathogens, etc”. Antec’s reaction, however, was to launch an efficacy testing programme unparalleled in disinfection.

Efficacy Testing Programme

It is important to note that Antec, although it carries out microbiological testing in its own laboratories, only uses independent test reports from centres of repute for clinical and promotional purposes. This is in marked contrast to competitors whose data and claims can be questionable to say the least. If asked for efficacy data against an organism, Antec supplies the independent test report. If the work has not been done, we do not claim activity.

a) Viruses

Certain key viruses crucial to human health were tested e.g.

HIV/AIDS	Institute of Cancer Research, London
Hepatitis B	London School of Hygiene & Tropical Medicine
Polio	Severn-Trent Laboratories, England
Rift Valley Fever	Porton Down
Lassa Fever	PHLS, Colindale

in order to establish VIRKON's virucidal efficacy. Further tests continued and now VIRKON is the only disinfectant proven effective against all eighteen families of viruses.

b) Bacteria

Although viruses are the most feared pathogens, it is bacteria which actually cause most human infections. Bacteria can be classified according to -

(i) Gram status
The Gram stain is a laboratory test in which a dye or stain is added to the bacteria. Depending on whether or not the bacteria retain or lose the stain, they are classed as Gram positive or negative.

(ii) Oxygen requirement
Bacteria broadly fall into two groups - those which thrive best in or require oxygen (aerobic) or those which either do not require or cannot grow in the presence of oxygen (anaerobic).

(iii) Antibiotic resistance
Antibiotics are chemicals which either poison the cell directly or copy key chemicals needed by micro-organisms. Because of subtle differences, if the bacteria use these copies instead of the originals then the process in question is hindered and the cell's functions compromised. Certain bacteria rapidly adapt themselves to produce forms which bypass the need for that chemical or destroy it and therefore become resistant to it. The excessive and indiscriminate use of antibiotics has led to strains of many important bacteria becoming resistant to many of the commonly

used antibiotics. This has led to many disease outbreaks and the need to switch to newer, much more expensive antibiotics.

VIRKON's testing programme encompasses all the major disease causing bacteria, e.g.

food poisoning organisms
- salmonella
- clostridia
- listeria
- shigella

major hospital pathogens
- Pseudomonas aeruginosa
- Staphylococcus aureus
- streptococci
- proteus
- klebsiellas

and covers Gram positive and negative aerobes and anaerobes, plus over 30 antibiotic resistant strains.

c) Fungi

Although not usually regarded as important as viruses and bacteria, fungi cause a wide range of skin disease e.g. athlete's foot, ringworm, vaginal and mouth thrush and also certain internal diseases.

At the time of writing, VIRKON has been proven effective against -

300 + strains/clinical isolates from 71 bacteria
50 + strains/clinical isolates from 15 fungi
70 + strains/clinical isolates from 33 viruses

a total of 331 strains/clinical isolates from 199 different organisms. Please note that by the time you read this that the figures will be considerably higher!
No other disinfectant has an efficacy database which begins to come close to VIRKON's and this database is the key element is VIRKON's sales story. There are three ways to use it:

a) Appendix I

This is the alphabetical list of organisms against which VIRKON has been proven effective and gives details of the organisms, strain, country of research, effective dilution and reference number of the report. Questions along the lines of "Does VIRKON work against organism X?" are quickly and effectively answered with Appendix I.

b) Appendix II

Appendix I, in the eyes of microbiologists is very simplistic in that it does not outline the conditions of the test. These can have a massive bearing on the outcome:

(i) dilution of disinfectant. Manufacturers do not always test at in-use dilutions. Instead, efficacy is 'established' at concentrations far higher than those recommended for practical use.

ii) temperature. In chemical reactions, a 10§C rise in temperature doubles the speed of reaction. Glutaraldehyde in tests is 100 times more effective at 25§C than 20§C against TB. Yet the manufacturers give TB recommendations based on 25§C data which are then used in hospital units which have an ambient temperature nearer to 15§C or less.

(iii) contact time. Activity of a disinfectant against a given organism may be shown in the test tube over say 30, 60 or 120 minute contact times. In practice, say on a surface, such extended contact times will never occur yet efficacy is still claimed, e.g. in the test tube alcohol is very effective against HIV, yet in practice it evaporates so quickly that it has no effect (a paper by Hanson in British Medical Journal - 1.4.89).

(iv) organic challenge. With the exception of VIRKON, the majority of disinfectants have their activity markedly reduced in the presence of organic material. Establishing activity in the clean conditions (no organic challenge) is only relevant if the product will never be used on surfaces where organic material is present - most unlikely.

(v) log reduction. Most tests call for a 4 log reduction of organisms to constitute a pass. Consider a situation where 10^8 (8 log) organisms are present per ml. A 4 log reduction would leave 8 log - 4 log = 4 log or 10,000 still present after the disinfectant has done its work. In an attempt to fudge matters further, some manufacturers use percentages, not logs. A 99.9% kill sounds excellent but killing 99.9% of 10^8 organisms per ml still leave 10,000 intact!
(What does log mean?
Log is a shorthand method for large numbers and the log number is basically the number of zeros after the 1 -

1,000 = 3 log

1,000,000,000 = 9 log

A reduction from 1,000,000,000 to 1,000 = 9 log - 3 log = a 6 log fall).

(vi) protocol. Several different methods or protocols exist for testing disinfectants all differing in the conditions used. All attempt to mimic real-life situations, but such are the drawbacks of existing products that some have great difficulty with certain tests. It is not uncommon for manufacturers to tailor protocols or test conditions to maximise their product's results.

Appendix II is unique in that for the first time a manufacturer has said "we don't use tailored protocols or adjust conditions to suit our product, we have nothing to hide". VIRKON has been tested under all conditions possible - high-low temperature/dilutions well above in-use recommendations/in the presence of a wide range of different organic challenges/at short and extended contact times using all the standard disinfectant testing protocols.

It is hard to envisage any other product whose manufacturer would dare to submit it to such close scrutiny.

Clearly, Appendix II is not for everyday detailed use in sales calls but is very useful with microbiologists and laboratory personnel.

c) Copies of papers

Every claim for VIRKON's activity is backed by an independent test report, copies of all of which are freely available on request. Simply offering the papers establishes VIRKON's efficacy is users' minds. It is a salutary experience to ask a competitor company for copies of test reports for organisms against which they claim activity. The classic response from one company was 'well, we haven't tested it against those particular organisms, but it was tested again 3 viruses, 6 bacteria and 2 fungi. It killed those so it will kill all the others'. This approach is:

(i) wholly unscientific
(ii) deliberately misleading
(iii) dangerous in that incorrect infection control procedures may be adopted
(iv) used by virtually all competitor companies

Virtually all disinfectants are promoted as capable of killing all pathogens. Hospital and laboratory workers believe that because something is called a disinfectant that it kills all organisms. We therefore must establish two key points for users.

(i) with the exception of hypochlorites and aldehydes, all the traditional disinfectants are ineffective against various important organisms. To use these products "across the board" is to take a risk.

(ii) manufacturers make unrealistic or inflated activity claims for products. Only one product has every activity claim backed by an independent test report.

Safety Testing Programme

All the components of VIRKON were selected with safety to the user to the fore. The following tests prove that the theoretical safety advantages of VIRKON's unique formu-lation occur in practice -

(i) Hazleton Laboratories skin and eye test.

Rat tests establish that the powder, even on long-term contact with shaved skin, is only a mild irritant. More importantly, EEC protocols used prove that a 1% solution of VIRKON is non-irritant to eyes and skin.

(ii) Acute oral toxicity

Dosing rats with VIRKON at the rate of 5000 mg per kg of body weight does not result in death.
(This is equivalent to a 70 kg man drinking 35 litres of 1% VIRKON!).

(iii) Animal groups were sprayed twice daily with 1% VIRKON - seven weeks for broilers and two weeks for pigs, calves and horses. No harmful or adverse effects were noted in comparison with control groups sprayed with water. (In fact, the VIRKON groups grew faster and converted food more efficiently). No residues were found in the flesh.

(iv) Virkon was added to chicken drinking water at a concentration of 0.5% for 42 days (they would not drink 1% VIRKON due to taste). No adverse differences were noted compared to a control group drinking water only.
The ability to combine unparalleled activity and spectrum with exceptional safety makes VIRKON unique.
The 'disinfectant dilemma' (efficacy or safety , not both) facing hospital and labora-tory workers has been abolished by the introduction of VIRKON.

Materials Testing Programme

VIRKON has been proven compatible against all non-metallic material with which it is likely to come into contact -

(i) Antec in-house tests

(ii) BCPC protocol using high concentration and no rinsing

(iii) Sprima (Scandinavian test centre of high repute) using extended contact times.

Provided it is used correctly, VIRKON is compatible with other materials -

a) Metals

The key determinants in VIRKON's compatibility are the type and condition of the metal and the length of each contact time. The works shown in the VIRKON technical book and quoted at VIRKON's launch was on new metal instruments of high quality. The shorter the contact time the better - instruments which show changes on 24 hours immersion in 1% VIRKON are unchanged when subjected to 144 cycles of 10 minute immersions (144 x 10 minutes = 24 hours) and rinsing.

The following conditions must be applied to VIRKON and metals -

(i) metal items must not be allowed to stand or soak in VIRKON (contact time should never exceed 10 minutes, 20 minutes for TB).

(ii) particular care is needed with acid sensitive metals, e.g. zinc, brass, copper, tin, aluminium, solder, mild steel

(iii) all contact must followed by rinsing with water

The regime agreed with the Department of Health for metal instruments and equip-ment is:

(i) prepare a 1% solution of VIRKON

(ii) wash the items in the VIRKON with a brush or mop until visibly clean

(iii) rinse in water

(iv) autoclave (if sterilisation required)

b) Carpets/textiles

The original test quoted in VIRKON technical book (page 34) shows no bleaching or staining caused by soaking in VIRKON solution. New data now leads to a powder then liquid recommendation for spillages. It is not possible to test the massive combination of textile materials and dyes available. Therefore all carpets or textiles should be tested for colour fastness by the user prior to use on spillages.

c) Plastics/laminates

Clear plastic containers in which VIRKON has stood may retain a slight pink coloration as do some laminates on which it has been used. Although cosmetically not pleasing, users do not object usually when considering the major advantages which VIRKON offers. (These slight tints can usually be removed by an alkaline detergent).

VIRKON in practice

a) Powder

The powder is supplied in 3 pack sizes -

50 g sachets (box of 50) for single use
500 g shaker pack (box of 6) for maximum convenience, ease of use on spillages
5 kg drum for maximum economy

The powder is stable for 3 years from manufacture. The pack should be used within 3 months of opening and re-sealed every time the product is used. The sachet is a single-use pack only.

b) Solution

To prepare a 1% solution, add 10 gm of powder (1 level measure of the provided scoop) to a litre of warm water, stir until dissolved (cold water can be used but it takes longer to dissolve). The 50 g pack should be added to 5 litres.

The solution is stable for at least 7 days (but good infection control practice indicates that all disinfectants would be replaced daily).

To test VIRKON solution for activity (e.g. in cases where high levels of metal or organic material are present):

(i) the colour dye in VIRKON indicates activity. Where oxidising levels fall, the pink dye reverts to its reduced, colourless form. Throw the solution away if the colour fades (milky white or light brown)

(ii) if VIRKON solution fails to turn starch iodide paper blue, discard it.

(iii) if a user requires a chemical assay to test solutions quantitatively, Antec will forward it.

VIRKON and spillages

- cover the spillage with VIRKON powder
- leave for 3 minutes
- scrape the spillage/powder mixture into a safe receptacle
- wash area with 1% VIRKON
- if the spillage was on carpeting or furnishing, vacuum when dry (having subjected sample to colour fastness test prior to usage).

VIRKON vs Hypochlorites/NaDCC on Spillages

VIRKON has two major advantages proven by Dr David Coates (Preston Public Health Laboratory) -

a) with the hypochlorites/NaDCC, although the surface on which the spillage occurred is effectively disinfected the disinfectant-spillage mixture still contains pathogen - a threat to safe disposal. With VIRKON, pathogens are killed both on the surface and in the disinfectant-spillage mixture.

b) using hypochlorites on a urine spill can result in so much toxic chlorine being evolved that wards have to be cleared (a UK Department of Health & Safety Action Bulletin has been circulated on this, copies available). VIRKON does not evolve chlorine on urine spills.

VIRKON and Surfaces

a) Hard Surfaces

Spray or wipe with 1% VIRKON using spray, mop or brush. Rinse/wipe with water if required after 10 minutes.

A white deposit may be left on surfaces after VIRKON solution has dried. This may be removed with a paper towel.

b) Metal Instruments or Equipment

See metals in Materials Testing Programme section page 25.

c) VIRKON and Flexible Endoscopes

Wipe outside of instrument and brush through channels with a 1% VIRKON solution.

Manual system - fill channels with and immerse instrument in 1% VIRKON for 10 minutes. Rinse with water.

Automatic system - fill detergent tank of autodisinfector with 0.5% VIRKON, disinfectant tank with 1% VIRKON and rinse tank with water. Cycle as normal.

Full details available separately in “Virkon in Flexible Endoscopy”.

d) VIRKON and Liquid-Handling Devices

eg. renal dialysis machines, blood analysers.

Flush lines through thoroughly with 1% VIRKON. Fill lines with 1% VIRKON, leave for 10 minutes. Flush lines thoroughly with water.

Features & Benefits of VIRKON

Feature	Benefit
Unique product, first new approach to disinfection in 40 years	Only approach designed for the particular infection control problems of the 90's
Multicomponent formulation	Resistance highly unlikely to develop, multiple biocide approach gives maximum spectrum
Developed by Antec International Ltd	Draws on the expertise of a leading disinfection company with the strongest history of innovative, research-based products
Worldwide, independent testing programme	Users can treat the results with respect and confidence
Efficacy claims made only on independent reports	Infection control decisions can be made on the basis of fact, not sales hype
Supplied as a powder	(i) easy, safe storage and transport (ii) excellent for spillage treatment
Powder does not evolve chlorine on urine spills	Replaces the unpleasant hypochlorites
Widest proven spectrum of any disinfectant	Simplifies infection control policy and maximises protection in situations where the pathogen is unidentified
Exceptional safety	The choice between efficacy and safety demanded by existing disinfectants does not apply to VIRKON
Solution non-irritant to skin and eyes	Elaborate protective clothing not required
No harmful vapour phase	Expensive ventilation not required
Does not possess a harmful vapour phase	No adverse COSHH implications
Used properly, compatible with all materials	Maximum range of uses, ease of use

Works by physically destroying organisms	Rapid protection for staff, ensures destruction of genetic (infective) material

Feature	Benefit
Can replace all existing disinfectants	Cost saving in inventory (storage costs, bulk purchase discounts) Cost savings in staff time and training Allows coherent, sensible infection control policies to be drawn up (and applied!)
Built-in dye	No need for test kit Ensures inactive solutions not used
Wide range of presentations	Pack size exists for single use/ convenience/economy
Combines cleaning and disinfection	Avoids the problems of pre-cleaning Reduces cost of materials and staff time

VIRKON vs 'The Ideal Disinfectant'

Earlier in this document, we considered the properties of the ideal disinfectant. How closely does VIRKON match up to this?

a. Total proven spectrum

We can only claim total spectrum when every strain of every organism has been tested. However, to date, VIRKON has been tested against the widest range of any disinfectant. It has yet to fail. It is therefore closer to total spectrum by far than any competitor.

b. Fast acting

Virkon works in minutes, even at low concentrations and in the presence of blood.

c. Cleans and disinfects in a single operation

Virkon avoids the need for pre-cleaning, eliminating transfer of organisms.

d. Safe for staff and the environment

Virkon fills this criteria.

e. Safe for materials and equipment

Used correctly, yes.

f. Suitable for multiple uses

Virkon is suitable for <u>all</u> cleaning and disinfection tasks.

g. Multiple-use product.

Virkon:

(i) simplifies training

(ii) simplifies infection control procedures - these are now more likely to be carried out correctly

(iii) saves money by reducing staff training, staff time and inventory costs

Conclusion

VIRKON is not yet the ideal disinfectant (although we are working on it!).

What is clear, however, is that it is much closer to the ideal disinfectant than any other product available and must be the first choice for any human health worker wishing to optimise microbiological efficacy.

THE 15 COMMONEST QUESTIONS ASKED ABOUT VIRKON

1. For how long should the solution be used?

When it is freshly made up, 1% Virkon solution should be stable for 1 to 2 weeks. Good infection control practice indicates that disinfectant solution should be changed daily, but this really is wasteful and far too expensive for most hospitals and laboratories to consider. We therefore recommend that Virkon solution is made up fresh at the beginning of each working week (Monday) and replaced every Monday morning. Of course, if the solution should lose colour within the intervening 7 days the solutions must be replaced immediately.

When Virkon solution is used for disinfecting metal instruments, experience indicates that it should be replaced every 20 uses. When it is used for cleaning heavily contaminated instruments it should be replaced for every cleaning cycle if a large amount of organic material is being released on each cleaning cycle.

For an explanation of how Virkon's dye works please see question number 15.

2. Why is Virkon only available as a powder?

Ideally we would like to have Virkon available as a powder for use on spillages and also as a liquid for immediate use when required. This, however, is not possible as the solution is only stable for a matter of 1 to 2 weeks.

What at first appears to be a disadvantage with Virkon is, in fact, a major advantage:

a) Because it is a powder Virkon takes up far less storage space than costly liquid disinfectants.

b) Transportation costs are considerably less for a concentrated powder than a concentrated or already diluted disinfectant. When people buy, for example, 2% activated glutaraldehyde they are paying for the transportation and storage of a product which is 98% water. This fact is well worth pointing out to your purchasing officers.

3. What is the powder's shelf life?

Stored correctly the powder is stable for at least 3 years from manufacture and the expiry date on the label states this clearly. We are gathering data to show that the shelf life in the future may be extended to 4 years. You will be updated on this.

4. For how long can metals be left in Virkon?

The original work carried out with Virkon and metal instruments used brand new instru-ments of a very high quality. Against these Virkon had very little or not corrosive effect.

In the real world, however, Virkon will often be used on damaged instruments or instru-ments where the plating or surfacing has been partially removed.

Considerable work has taken place with Virkon and instruments and the key result of this is that if used correctly Virkon will not damage instruments.

By used correctly, we mean limiting the immersion time to no more than 10 minutes. Immersing instruments in Virkon long term will undoubtedly lead to corrosion or damage. (The time scale required depends on the quality and type of metal involved.) We therefore recommend that instruments are not left in Virkon for more than 10 minutes. In fact it is possible to both clean and disinfect instruments without any immersion whatsoever and the following wording has been agreed with the United Kingdom Department of Health. In order to clean and disinfect metal instruments in one process:

a) Make up fresh 1% Virkon solution. (10g of Virkon powder per 1 litre of warm water).

b) Thoroughly clean the instruments in the Virkon solution until all organic material is visibly removed.

c) Rinse the instruments in water.

The above procedure will give instruments which are both cleaned and disinfected (please note, if sterilisation is required then a further sterilisation process must take place). By using this process your end users will be able to both clean and disinfect instruments without the possibility of corrosion occurring. It also has major advantages for end users in that it saves money both in terms of detergent and disinfectant chemicals used, but also in terms of staff time required.

5. How do I make up a 1% solution?

A 1% solution is 1 part Virkon to 100 parts of water.

The simplest way to make this up is to use 10 grams of Virkon powder per litre of warm water. (You can of course use cold water but it will take longer for the powder to dissolve). Do not use hot water (greater than 40§C).

On adding the powder to the water stir the solution and wait for all the components to dissolve and for the powder to be a clear, pink solution. In a very hard water area the surfactant flakes (white) can take longer to dissolve than the other components.

6. How does Virkon work?

Virkon does not work as a chemical poison like the other existing disinfectants. Instead of being a single chemical poison Virkon is in fact a mixture of 6 different biocides all designed to work together in harmony against different physical and chemical structures within the micro-organism. This gives Virkon an unparalleled range of activity against micro-organisms with the result that no organism tested to date has proved resistant to Virkon.

When this scheme was being put together the chemicals chosen had to be of the highest safety profile resulting in Virkon, although being a new product, having a safety profile going back some 20 or 30 years.

For a more full description of how Virkon works see the section on Mode of Action in the main body of the document. (Pages 17 & 18).

7. Does Virkon kill TB?

Why are both 1 and 3% Virkon solutions recommended?

Yes, Virkon does kill TB - Dr Cutler at St Andrews Hospital in London has produced data on this which have been submitted to journals for publication.

In the test tube only Virkon's disinfectant activity can be measured - i.e. Virkon's surfactant/detergent properties are not evaluated. Using this method therefore 3% Virkon is required in order to kill TB satisfactorily.

In real life, however, the main concern about TB is contamination of instruments. Here both cleaning and disinfection take place and in both these instances Virkon scores highly. Dr Cutler contaminated bronchoscopes with Mycobacterium tuberculosis and then both cleaned and disinfected them with 1% Virkon solution. In all instances that he measured no TB could be recovered.

Therefore on the largely theoretical basis of test tube work 3% Virkon is required but in the real life world where both cleaning and disinfection take place 1% Virkon should be used for instruments contaminated with TB.

8. Does Virkon kill spores?

Yes, Virkon does kill spores - a summary of its sporicidal activity is given below and overleaf and copies of all the relevant test reports are freely available on request.

A key point to consider is that for disinfection spores do not necessarily have to be killed. Having said that, however, spores are important so if a disinfectant does have sporicidal activity that is to its advantage. Also sporicidal activity is an indicator of how effective a disinfectant is.

A. Dr Coates - Preston Public Health Laboratory

Bacillus subtilis

B. Prof Dubini - Dept of Microbiology, University of Milan

Aspergillus niger
Bacillus subtilis

C. Laboratoire Simone, Belgium (5-5-5 Protocol)

Bacillus cereus
Clostridium sporogenes

D. Dep de Microbiologia, Faculdade de Farmacia da Universidade de Lisboa

Bacillus cereus (AFNOR protocol)

A summary of results is given overleaf.

	Virkon	Starting Count	Contact Time (Mins)									
			1	5	10	15	20	30	45	60	120	180
B. subtilis	1%	$3.2x10^7$	-	-	-	-	-	-	-	3-5	>5	>5
(Dr	2%	$3.2x10^7$	-	-	-	2-3	-	>5	>5	>5	-	-
Coates)	3%	$3.2x10^7$	-	-	-	4-5	-	5	5	5	-	-
B. cereus (Lisbon University)	1%	$1x10^7$	-	-	-	-	-	-	-	>5	-	-
B. subtilis	1%	$1x10^6$	G	G	G	-	G	G	-	NG	-	-
(Prof	1%	$1x10^5$	NG	NG	NG	-	NG	NG	-	NG	-	-
Dubini)	1%	$1x10^4$	NG	NG	NG	-	NG	NG	-	NG	-	-
A. niger	1%	$1x10^6$	G	G	G	-	G	NG	-	NG	-	-
(Prof	1%	$1x10^5$	G	G	G	-	NG	NG	-	NG	-	-
Dubini)	1%	$1x10^4$	G	G	NG	-	NG	NG	-	NG	-	-
B. cereus (Lab Simone)	1%	$6.0x10^5$	-	Zero recovery	-	-	-	-	-	-	-	-
C. sporo-genes (Lab Simone)	1%	$2.9x10^7$	-	Zero recovery	-	-	-	-	-	-	-	-

Numbers = log reductions recorded, G = Growth NG = No Growth, - = no measurement at this time point

9. Can I sterilise with Virkon?

This is of course related to the previous question. Sterilisation is the killing of all organisms present including all spores. Whilst Virkon, hypochlorite and the aldehydes can deliver extremely high level disinfection (greater than 99.999% kill) it is becoming increasing excepted that you cannot and must not sterilise with cold liquid. Only an effective autoclave, ethylene oxide treatment or gamma irradiation can guarantee sterilisation.

In many markets glutaraldehyde is marketed as a "sterilizing solution". The indicator time for so-called sterilisation with glutaraldehyde varies widely from market to market with the range being some 3 to 10 hours. In fact, in the UK many hospitals immerse in glutaraldehyde for 10 to 30 minutes and assume that they have sterilised. They have not - they are deluding themselves and placing their staff and patients at considerable risk from infection.

10. How much powder should I use on spills?

It is not necessary to swamp a spillage with Virkon to a depth of several centimetres in order to decontaminate it effectively. Instead the spillage should be lightly covered, left for 3 minutes for Virkon to soak up the spillage and then scraped away safely into a receptacle for disposal. As a final guarantee, the surface should be washed with a 1% Virkon solution.

11. Why does Virkon sometimes leave residues?

Occasionally when Virkon solution is used on a surface as a spray but particularly as a wipe a white residue can sometimes be left behind. This white residue is normally the surfactant. If you frequently find that a residue is left behind it means simply that you are using too much solution on the surface. But in any event the residue can easily be removed afterwards with a dry paper towel.

There are occasions when it is extremely important to ensure that there are no Virkon residues left on the surface. One such example would be when Virkon is used for cleaning and disinfecting the tubing within an analysis machine. Any residues of Virkon left behind could chemically interfere with assays which take place subsequently.

The way to test for Virkon residues is to test the rinse or flushing water which is used as the final step in the decontamination procedure. All laboratories should have in their possession simple starch iodide paper. This is white but when dipped into a solution of Virkon or other oxidising system it will turn blue. Therefore if the starch iodide paper turns blue then Virkon has not been removed and the rinsing flushing must take place again until the starch iodide paper stays white.

12. What special precautions do I need when using Virkon?

In a word, none.

Virkon solution is non irritant to skin and eyes therefore goggles and gloves are not required (although, of course, gloves should be worn in any infection control situation). Virkon does not have a toxic vapour phase therefore extraction/ventilation equipment is not required. The only precaution to be taken when using Virkon is that you must not inhale the powder. This instruction, however, would go for all powders whether it be talcum powder, flour, etc.

13. Does Virkon cause cancer?

This is an important question as certain hospital decontaminates are known to be cancer causing (carcinogenic) - most notably formaldehyde.

All of the work carried out on Virkon to date for ability to cause cancerous changes or mutagenic changes indicates that it does not have carcinogenic potential.

14. Can I make up Virkon holding solutions?

Virkon solution of course should be made up in the main at 1% concentration. Rather than make up large amounts of 1% solution at once some users would find it more convenient to make up more concentrated solutions in one batch and then dilute this down as needed. This concentrated solution is known as the "holding solution".

Unfortunately the maximum solubility of Virkon is 4%. Therefore if someone makes up what they think is 20% Virkon holding solution and then dilute this down 20 times to give 1%, they are in fact diluting 20 fold a 4% solution and are ending up with a 0.2% solution.

Therefore Virkon cannot be used to make up holding solutions.

15. Why does Virkon solution sometimes lose colour in a matter of days?

Virkon solution is designed to last for at least 1 to 2 weeks. Over-exposure of a solution, however, to organic material or metal instruments can cause oxidising activity to be lost in a shorter time than this and this is reflected by the pink colour of the solution being lost. At this point of course the solution must be discarded and replaced with fresh solution. There are other occasions when the solution loses colour -

a) New plastic bottles or containers may have traces of mould-release agent (chemicals added during the manufacturing process). Interaction with the dye within Virkon can cause the dye to be lost even though the solution is still active.

b) If Virkon solution is made up in a container with traces of an incompatible chemical within it (e.g. bleach) then the solution may lose colour.

c) It is important that users discard Virkon solution properly and rinse the container before replenishing the solution. Merely adding powder and water to the remains of an old Virkon solution will cause the colour to be lost sooner than if the solution is made up completely fresh within a clean container.

We therefore can see that it might be possible for Virkon to lose its pink colour whilst still retaining its activity. It is most important to point out that it is not possible for Virkon solution to lose its activity but still retain its pink colour. The important conclusion of this is that the consumer is always protected - if the solution has lost its colour then it has lost its activity and must be thrown away immediately.

COMPETITOR PROFILES

1. Hypochlorites
2. Sodium dichloroisocyanurate (NaDCC)
3. Aldehydes
4. Diguanides
5. Alcohols
6. Synthetic phenols
7. Quaternary Ammonium Compounds (QAC's)
8. Iodine/iodophors

HYPOCHLORITES

Trade Names	Manufacturers
Wide range of branded and commodity versions available	

Features	Comments
Good activity under clean conditions against viruses bacteria fungi spores mycobacteria	Wide spectrum of activity
Rapidly inactivated by organic matter (Bloomfield - Journal of Hospital Infection 1989 13 231)	Efficacy greatly reduced by blood, urine, etc
Pre-cleaning essential (Moliari - Journal Am Dent Assoc 1988 117 179)	Doubles the work and increases the risk of spreading contamination
Unstable, rapidly lose activity at room temperature or if contaminated by metal	User can never be sure if surface has been disinfected properly
Highly corrosive to metals	Severely limits use
Bleaches textiles and carpets	Cannot be used on spills on carpets
Chlorine evolved when applied to urine spills (U.K. Department of Health Safety Bulletin)	Limits spill usage further
Suitable for environmental use only	

For	Against
Wide spectrum of activity	Rapidly inactivated by organic matter Pre-cleaning essential Unstable, rapidly lose activity at room temperature or in contact with metal Highly corrosive to metals Bleach textiles and carpets Chlorine evolved when applied to urine spills Suitable for environmental use only

SODIUM DICHLOROISOCYANURATE (NaDCC)

Trade names	Manufacturer
Presept granules (30% w/v available chlorine)	Surgikos Ltd/Johnson&Johnson
Hazard Tab granules (60% w/v available chlorine)	Guest Hygiene Ltd.
Biospot powder (30% w/v available chlorine)	HydraChem Ltd
Virusorb absorbent powder (10% w/v available chlorine)	Setton Prebbles Ltd
Titan Sanitizer (2.2% w/v available chlorine)	Lever Industrial Ltd.

Features	Comments
Available as granules	Good for absorbing spillages
Available as tablets	Good for storage and transport but solution has to be made up
Good activity under clean conditions against viruses bacteria fungi spores mycobacteria	Wide spectrum of activity
Rapidly inactivated by organic matter (Bloomfield - Journal of Hospital Infection 1989 13 231)	Efficacy greatly reduced by blood, urine, etc
Pre-cleaning essential (Moliari - Journal Am Dent Assoc 1988 117 179)	Doubles the work and increases the risk of spreading contamination
Unstable, rapidly lose activity at room temperature or if contaminated by metal	User can never be sure if surface has been disinfected properly
Highly corrosive to metals	Severely limits use
Bleaches textiles and carpets	Cannot be used on spills on carpets

Features	Comments
Chlorine evolved when applied to urine spills (U.K. Department of Health Safety Bulletin)	Limits spill usage further
Expensive compared to liquid hypochlorite	
Suitable for environmental use only	

For	Against
Wide spectrum of activity Available as tablets and granules	Rapidly inactivated by organic matter Pre-cleaning essential Unstable, rapidly lose activity at room temperature or in contact with metal Highly corrosive to metals Bleach textiles and carpets Chlorine evolved when applied to urine spills Expensive compared to liquid hypochlorite Suitable for environmental use only

ALDEHYDES

Commonest form is glutaraldehyde.

Trade Names	Manufacturers
Cidex (2% alkaline glutaraldehyde) Totacide (2% alkaline glutaraldehyde) Asep (2% alkaline glutaraldehyde) Gigasept (Butan 1-4 dial/2,5 dimethoxy tetrahydrofuran and formaldehyde)	Surgikos/Johnson & Johnson

Features	Comments
Good activity against viruses bacteria fungi spores TB	Wide spectrum
Activity claims based on extended contact times - in terms of hours for spores and mycobacteria	Not for use as a surface disinfectant
Claimed to be effective against mycobacteria, including TB - data used is from old protocols	Concern is being expressed about these claims
Work best at elevated temperatures - should be used at 45§C in endoscope disinfection in the U.S. (activity against TB is 100 times greater at 25§C than 20§C)	What is the background temperature in places using glutaraldehyde in your markets?
Cidex available as standard and long- life formulations (14 and 28 days), test kit available	Users do not know of or possess test kit - out of date or exhausted solutions frequently in use
"Fix" proteins, activity greatly reduced by organic material Pre-cleaning required	Even more than the other disin-fectants, pre-cleaning is absolutely essential with the aldehydes
The liquid and its vapour are recognised as toxic - skin dermatitis eyes conjunctivitis lungs/ rhinitis respiratory tract sinusitis asthma	When making up solutions, users should wear eye protection, thick rubber gloves and, if need be, respiratory protectors Extraction/ventilation systems should be installed

Features	Comments
The cost of installing ventilation equipment in an operating theatre is of the order of £30,000+.	
The U.K. Health and Safety Executive sets a Maximum Exposure Limit of 0.2 parts per million for short-term (10 minutes) atmospheric aldehyde exposure	Few hospitals can monitor properly - most simply break the law
People sensitive to glutaraldehyde may exhibit distress at exposure levels far below the 0.2ppm legal limit	
All of the above combine to restrict the use of the aldehydes to the disinfection of instruments, particularly those which cannot be autoclaved	Market leader in “cold sterilant” market - misleading as it is not a true sterilant
The manufacturers literature warns that corrosion and electrolytic deposition occurs if instruments of different metals are immersed together	The aldehydes are regarded as non-damaging to metals
Formaldehyde has a specific use in some markets - the vapour is “fogged” in operating theatres weekly to disinfect them	Specialised, expensive fogging equipment is required The vapour is an irritant and a recognised carcinogen(cancer-causing agent).

For	Against
Very wide spectrum in laboratory tests Extended life formulations available	Very long contact times required in practice Very temperature and pH dependent Concern over TB claims Fix proteins Pre-cleaning essential Toxic - eye, skin and respiratory tract problems Formaldehyde is carcinogenic Instrument disinfection only

DIGUANIDES

The term “diguanide” usually means chlorhexidine, introduced by ICI in the late 1940’s, and marketed as Hibiscrub, Hibisol and Hibitane.

Trade Names	Manufacturers
Hibiscrub, Hibisol, Hibitane	ICI

Features	Comments
Activity Viruses Poor Gram-negative bacteria Poor Spores None Fungi Poor TB None	Due to long-term, high-profile promotion by ICI over 40 years most users assume that chlorhexidine kills everything - why not educate them?
Acceptable activity against gram- positive bacteria	If the user can guarantee that only gram-positive bacteria are present then chlorhexidine is a valid choice - unlikely!
Rapid resistance developed by Pseudomonas aeruginosa (one of the most important Gram -ive hospital bacteria)	Pseudomonas is frequently found growing in chlorhexidine solutions
Long-term use can lead to problems following absorption through the skin (brain and central nervous system damage, infertility?)	One of the reasons why chlorhexidine is used is because it has a carefully constructed safe image!
Causes skin chapping and damage on repeated use	Many users rub in skin creams to help this. Many of these contain cationic surfactants - chlorhexidine is inactivated by these
The diguanides are reserved for skin disinfection (antisepsis)	

For	Against
Kill gram-positive bacteria Has safe image	Massive gaps in spectrum Rapid resistance developed by Pseudomonas aeruginosa Problems associated with long-term use Causes skin chapping and drying Reserved for skin disinfection

ALCOHOLS

Trade Names	Manufacturers

Features	Comments
Reasonable activity in laboratory tests	
No activity against spores	
Evaporate rapidly	No sustained activity on surfaces against HIV (BMJ, April 1st, 1989)
Maximum activity at 70:30 alcohol/ water mix	Activity falls off rapidly if ratio is wrong or if solution absorbs excess water
Requires pre-cleaning	Doubles number of tasks, increases scope for spread of contamination
Inactivated by organic matter	
Extremely flammable	Major storage problems
Dries and irritates the skin	
Very expensive	

For	Against
Reasonable activity in laboratory tests	Evaporate rapidly - no sustained activity on surfaces against HIV No activity against spores Alcohol/water ratio crucial Require pre-cleaning Inactivated by organic material Extremely flammable Expensive

SYNTHETIC PHENOLS

Trade Names	Manufacturers

Features	Comments
Excellent TB activity, limited activity against viruses and spores	Can users be sure that surface/instrument only carries TB? Unlikely
Require pre-cleaning	
Incompatible with cationic detergents	Must use care in selecting and rinsing away detergent used for pre-cleaning
Like QAC's, biostatic effect can interfere with action of bacterial sewage filtration beds	Legislation re disposal may be forthcoming
Excessive contact with the skin must be avoided - not to be used on surfaces or equipment which may come into contact with skin or mucous membranes. Can be absorbed by rubber and plastics. Suitable for low-level environmental use only	Severely limits use

For	Against
Disinfectant of choice for TB on surfaces	Limited spectrum otherwise require pre-cleaning Environmental impact can only be used on areas not coming into contact with skin or mucous membranes Suitable for low-level environmental use only.

QUATERNARY AMMONIUM COMPOUNDS

Known as “Quats” or “Q.A.C.’s”

Trade Names	Manufacturers

Features	Comments
Very limited virucidal action, no activity against spores or TB	Limited to low-level disinfection
Rapidly inactivated by hard water and organic material	
Require pre-cleaning	
Poor environmental profile - biostatic action	Can interfere with bacterial sewage filter beds
Surface use only	

For	Against
	Limited spectrum Rapidly inactivated by hard water and organic material Require pre-cleaning Environmental impact Limited to surface use

IODINE/IODOPHORS

Trade Names	Manufacturers

Features	Comments
Limited activity against viruses and spores	
Heavily inactivated by presence of organic material	
Pre-cleaning essential	
Activity depends on acidity of formulation and chemical availability of the iodine	Wide variation in strengths of products available
Suitable for low-level skin and environmental disinfection following pre-cleaning	

For	Against
	Limited spectrum Pre-cleaning crucial Wide variation in strengths available Limited to low-level environmental disinfection of cleaned surfaces plus skin