



**Appendix D: Review of Published Data - Table 13 : Quaternary Ammonium Compounds  
Enveloped Viruses**

Virus/ Strain	Statement of Identity	Active Ingredient/ Concentration	Active Conc. Tested	Viral Diluent	Test Type/ Carrier	Test Method/Description	Contact Time	Virucidal Results	Ref.
HBV (Duck)	Disinfectant	25% BZK 1, 25% EBAC	703 ppm in 300 ppm AOAC hard water	Duck serum	Plastic	<b>Time Kill Method.</b> 0.2mL viral suspension dried 1 hour on tissue culture dish, exposed to 2mL test material in PBS. Following contact time, neutralized by dilution with L15 medium containing 5% FBS and assayed in duckling hepatocytes.	10 minutes	≥99.9% inactivated	Prince <i>et al.</i> , 1993
HBV (Duck)	Disinfectant	25% BZK 1, 25% EBAC	500 ppm in 300 ppm AOAC hard water	Duck serum	Plastic	<b>Time Kill Method.</b> 0.2mL viral suspension dried 1 hour on tissue culture dish, exposed to 2mL test material in PBS. Following contact time, neutralized by dilution with L15 medium containing 5% FBS and assayed in duckling hepatocytes.	10 minutes	≥99.9% inactivated	
HBV (Human)	Disinfectant	25% BZK 1, 25% EBAC	703 ppm in 300 ppm AOAC hard water	5% Chimpan- zee plasma	Glass	<b>Time Kill Method.</b> Approximately 5 log <sub>10</sub> viral suspension dried 30 minutes on petri dish, exposed to 2mL test material. Following contact time, neutralized by dilution with 11mL chimpanzee plasma. Infectivity of virus assayed by electron microscopy.	10 minutes	≥90% of remaining virions severely morpho- logically altered	
HBV (Human)	Disinfectant	25% BZK 1, 25% EBAC	500 ppm in 300 ppm AOAC hard water	5% Chimpan- zee plasma	Glass	<b>Time Kill Method.</b> Approximately 5 log <sub>10</sub> viral suspension dried 30 minutes on petri dish, exposed to 2mL test material. Following contact time, neutralized by dilution with 11mL chimpanzee plasma. Infectivity of virus assayed by injection of entire reaction mixture into chimpanzees.	10 minutes	≥99.9% rendered non- infectious	
HBV (Human)	Disinfectant	25% BZK 1, 25% EBAC	500 ppm in 300 ppm AOAC hard water	5% Chimpan- zee plasma	Glass	<b>Time Kill Method.</b> Approximately 5 log <sub>10</sub> viral suspension dried 30 minutes on petri dish, exposed to 2mL test material. Following contact time, neutralized by dilution with 11mL chimpanzee plasma. Infectivity of virus assayed by electron microscopy.	10 minutes	≥90% of remaining virions severely morpho- logically altered	
HBV (Human)	Disinfectant	25% BZK 1, 25% EBAC	703 ppm in 300 ppm AOAC hard water	5% Chimpan- zee plasma	Glass	<b>Time Kill Method.</b> Approximately 5 log <sub>10</sub> viral suspension dried 30 minutes on petri dish, exposed to 2mL test material. Following contact time, neutralized by dilution with 11mL chimpanzee plasma. Infectivity of virus assayed by injection of entire reaction mixture into chimpanzees.	10 minutes	≥99.9% rendered non- infectious	
Herpes (Feline)	Disinfectant	DDAC 1 BZK 3	0.0293%, 0.0195%	5% FBS	Suspension	<b>Time Kill Method.</b> 2.5mL viral suspension exposed to 2.5mL test material (2X concentration). Following contact time, neutralized by dialysis against 5 changes of R-saline and assayed in CRFK cells.	10 minutes	6 log <sub>10</sub> reduction	Kennedy <i>et al.</i> , 1995

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Herpes (Feline)	Disinfectant	DDAC 1 BZK 3	0.0359%, 0.0234%	5% FBS	Suspension	<b>Time Kill Method.</b> 2.5mL viral suspension exposed to 2.5mL test material (2X concentration). Following contact time, neutralized by dialysis against 5 changes of R-saline and assayed in CRFK cells.	10 minutes	6 log <sub>10</sub> reduction	Kennedy <i>et al.</i> , 1995
Herpes (Feline)	Disinfectant	BZK 3, DDAC 2, DDAC 1, DDAC 3	0.0117%, 0.0088%, 0.0044%, 0.0044%	5% FBS	Suspension	<b>Time Kill Method.</b> 2.5mL viral suspension exposed to 2.5mL test material (2X concentration). Following contact time, neutralized by dialysis against 5 changes of R-saline and assayed in CRFK cells.	10 minutes	5 log <sub>10</sub> reduction	
Herpes (Feline)	Disinfectant	DDAC 1, BZK 3	0.0195- 0.0390%, 0.0195- 0.0390%	5% FBS	Suspension	<b>Time Kill Method.</b> 2.5mL viral suspension exposed to 2.5mL test material (2X concentration). Following contact time, neutralized by dialysis against 5 changes of R-saline and assayed in CRFK cells.	10 minutes	4 log <sub>10</sub> reduction	
Herpes Simplex-I	Disinfectant	2.680% BZK 2, 2.010% DDAC 2, 1.355% DDAC 1, 1.005% DDAC 3	1:128 in 400ppm hard water as CaCO <sub>3</sub>	5% FBS	Suspension	Not available	Not available	>7 log <sub>10</sub> reduction	The Brulin Corporation, Undated
Herpes Simplex-II	Disinfectant	2.680% BZK 2, 2.010% DDAC 2, 1.355% DDAC 1, 1.005% DDAC 3	1:128 in 400ppm hard water as CaCO <sub>3</sub>	5% FBS	Suspension	Not available	Not available	>5 log <sub>10</sub> reduction	
Herpes Simplex	Germicide	BZK 4	1:10000	Maint. media in EBSS	Suspension	<b>Time Kill Method.</b> 0.1mL viral inoculum was added to 0.9mL test material and mixed. Following contact time, the virus was grown in rabbit kidney cells.	10 minutes	Inactivated virus	Klein and Deforest, 1963b
HIV	Disinfectant	1.536% DDAC 2, 0.768% DDAC 3, 0.768% DDAC 4, 12.288% BZK 3	0.08%	50% human plasma	Suspension	Not available	1 minute	<6.0 log <sub>10</sub> reduction	Sattar and Springthorpe, 1991

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HIV	Disinfectant	1.536% DDAC 2, 0.768% DDAC 3, 0.768% DDAC 4, 12.288% BZK 3	0.08%	50% human plasma	Suspension	Not available	10 minutes	>7.0 log <sub>10</sub> reduction	Sattar and Springthorpe, 1991
HIV	Disinfectant	5.8% BZK 1, 5.8% EBAC	0.047%	10% FCS	Carrier	Not available	10 minutes	>3.0 log <sub>10</sub> reduction	
HIV	Disinfectant	3.0% BZK 1	0.047%	10% FCS	Carrier	Not available	10 minutes	>3.0 log <sub>10</sub> reduction	
HIV	Disinfectant	1.536% DDAC 2, 0.768% DDAC 3, 0.768% DDAC 1, 12.288% BZK 5	0.06%	10% FCS	Carrier	Not available	10 minutes	>3.0 log <sub>10</sub> reduction	
HIV	Disinfectant	6.0% BZK 1, 6% EBAC	0.047%	10% FCS	Carrier	Not available	10 minutes	>3.0 log <sub>10</sub> reduction	
HIV	Disinfectant	BZK 4	0.005- 0.01%	10% FCS	Suspension	Not available	10 minutes	8-53%	
HIV	Disinfectant	BZK 4	0.05- 0.08%	10% FCS	Suspension	Not available	10 minutes	0.03-0.04%	
HIV	Disinfectant	BZK 4	0.05%	Infected cells + genital secretions	Suspension	Not available	5 minutes	All detectable	
HIV-1	Disinfectant	0.105% BZK 1, 0.105% EBAC, 5-10% diethyl- ene glycol butyl ether	Not available	Not available	Not available	Not available	10 minutes	3 log <sub>10</sub> reduction	Caltech Industries, 1999
HPIV-3	Disinfectant	BZK 2	0.04%	feces or bovine mucin	Stainless steel	<b>Carrier Method.</b> 10µL viral suspension inoculated on carrier and dried 1 hour. 20µL test material placed on carrier. After contact time mixture neutralized by dropping carrier in 1mL TPB. Virus assayed in MA-104 cells.	1 minute	<3 log <sub>10</sub> reduction	Sattar <i>et al.</i> , 1989

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HPIV-3	Toilet cleaner	BZK 2, Hydrochloric acid	0.04% BZK 2, 7% Hydro- chloric acid	feces or bovine mucin	Stainless steel	<b>Carrier Method.</b> 10µL viral suspension inoculated on carrier and dried 1 hour. 20µL test material placed on carrier. After contact time mixture neutralized by dropping carrier in 1mL TPB. Virus assayed in MA-104 cells.	1 minute	≥3 log <sub>10</sub> reduction	Sattar <i>et al.</i> , 1989
HPIV-3	Not available	BZK 2, Ethanol	0.04% BZK 2, 70% Ethanol	feces or bovine mucin	Stainless steel	<b>Carrier Method.</b> 10µL viral suspension inoculated on carrier and dried 1 hour. 20µL test material placed on carrier. After contact time mixture neutralized by dropping carrier in 1mL TPB. Virus assayed in MA-104 cells.	1 minute	≥3 log <sub>10</sub> reduction	
HPIV-3	Not available	BZK 2, Sodium metasilicate	0.04% BZK 2, 0.5% Sodium meta- silicate	feces or bovine mucin	Stainless steel	<b>Carrier Method.</b> 10µL viral suspension inoculated on carrier and dried 1 hour. 20µL test material placed on carrier. After contact time mixture neutralized by dropping carrier in 1mL TPB. Virus assayed in MA-104 cells.	1 minute	≥3 log <sub>10</sub> reduction	
HTLV-III (H9)	Not available	1.536% DDAC2, 0.768% DDAC3, 0.768% DDAC4, 12.288% BZK3	0.08%	50% Human Plasma	Suspension	<b>Time Kill Method.</b> Virus infected cells were mixed with test material. After contact time, cells cocultivated with uninfected H9 cells. Infectivity assays were measured by microscopic examination of cytopathic effects and reverse transcriptase activity in supernatant fluid	1 minute	<6 log <sub>10</sub> reduction TCID <sub>50</sub>	Resnick <i>et al.</i> , 1986
HTLV-III (H9)	Not available	1.536% DDAC2, 0.768% DDAC3, 0.768% DDAC4, 12.288% BZK3	0.08%	50% Human Plasma	Suspension	<b>Time Kill Method.</b> Virus infected cells were mixed with test material. After contact time, cells cocultivated with uninfected H9 cells. Infectivity assays were measured by microscopic examination of cytopathic effects and reverse transcriptase activity in supernatant fluid	10 minutes	≥7 log <sub>10</sub> reduction TCID <sub>50</sub>	
Human coronavirus (229E)	Disinfectant	BZK 2	0.04%	feces or bovine mucin	Stainless steel	<b>Carrier Method.</b> 10µL viral suspension inoculated on carrier and dried 1 hour. 20µL test material placed on carrier. After contact time mixture neutralized by dropping carrier in 1mL TPB. Virus assayed in L-132 cells.	1 minute	<3 log <sub>10</sub> reduction	Sattar <i>et al.</i> , 1989
Human coronavirus (229E)	Toilet cleaner	BZK 2, Hydrochloric acid	0.04% BZK 2, 7% Hydro- chloric acid	feces or bovine mucin	Stainless steel	<b>Carrier Method.</b> 10µL viral suspension inoculated on carrier and dried 1 hour. 20µL test material placed on carrier. After contact time mixture neutralized by dropping carrier in 1mL TPB. Virus assayed in L-132 cells.	1 minute	≥3 log <sub>10</sub> reduction	

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Human coronavirus (229E)	Not available	BZK 2, Ethanol	0.04% BZK 2, 70% Ethanol	feces or bovine mucin	Stainless steel	Carrier Method. 10µL viral suspension inoculated on carrier and dried 1 hour. 20µL test material placed on carrier. After contact time mixture neutralized by dropping carrier in 1mL TPB. Virus assayed in L-132 cells.	1 minute	≥ 3 log <sub>10</sub> reduction	Sattar <i>et al.</i> , 1989
Human coronavirus (229E)	Not available	BZK 2, Sodium metasilicate	0.04% BZK 2 0.5% Sodium meta- ilicate	feces or bovine mucin	Stainless steel	Carrier Method. 10µL viral suspension inoculated on carrier and dried 1 hour. 20µL test material placed on carrier. After contact time mixture neutralized by dropping carrier in 1mL TPB. Virus assayed in L-132 cells.	1 minute	≥ 3 log <sub>10</sub> reduction	
Infectious Bronchitis (Avian)	Disinfectant	2.680% BZK 2, 2.010% DDAC 2, 1.355% DDAC 1, 1.005% DDAC 3	1:128 in 400ppm hard water as CaCO <sub>3</sub>	5% FBS	Suspension	Not available	Not available	>6 log <sub>10</sub> reduction	The Brulin Corporation, Undated
Infectious Rhino- tracheitis virus (Bovine)	Disinfectant	2.680% BZK 2, 2.010% DDAC 2, 1.355% DDAC 1, 1.005% DDAC 3	1:128 in 400ppm hard water as CaCO <sub>3</sub>	5% FBS	Suspension	Not available	Not available	>6 log <sub>10</sub> reduction	The Brulin Corporation, Undated
Influenza (Asian)	Germicide	BZK 4	1:10000	Maint. media in EBSS	Suspension	Time Kill Method. 0.1mL viral inoculum was added to 0.9mL test material and mixed. Following contact time, the virus was grown in the allantoic cavity of the chick embryo.	10 minutes	Inactivated virus	Klein and Deforest, 1963b
Influenza (Avian)	Disinfectant	2.680% BZK 2, 2.010% DDAC 2, 1.355% DDAC 1, 1.005% DDAC 3	1:128 in 400ppm hard water as CaCO <sub>3</sub>	5% FBS	Suspension	Not available	Not available	>7 log <sub>10</sub> reduction	The Brulin Corporation, Undated

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Influenza Type A	Disinfectant	2.680% BZK 2, 2.010% DDAC 2, 1.355% DDAC 1, 1.005% DDAC 3	1:128 in 400ppm hard water as CaCO <sub>3</sub>	5% FBS	Suspension	Not available	Not available	>7 log <sub>10</sub> reduction	The Brulin Corporation, Undated
Rubella	Disinfectant	2.680% BZK 2, 2.010% DDAC 2, 1.355% DDAC 1, 1.005% DDAC 3	1:128 in 400ppm hard water as CaCO <sub>3</sub>	5% FBS	Suspension	Not available	Not available	>6 log <sub>10</sub> reduction	The Brulin Corporation, Undated
Vaccinia (vSIGK3)	Disinfectant	12% octylphen- oxypolyethoxy ethanol, 20% BZK	1:1250	Undiluted	Suspension	<b>Time Kill Method.</b> 10µL (8 log <sub>10</sub> /mL) viral inoculum was added to 10µL test material and mixed. Following contact time, the mixture was neutralized by dilution in complete CMEM and plated on BSC-1 cells.	15 seconds	~8.9 log <sub>10</sub> virus surviving	Jonczy <i>et al.</i> , 2000
Vaccinia (vSIGK3)	Disinfectant	12% octylphen- oxypolyethoxy ethanol, 20% BZK	1:1250	Undiluted	Suspension	<b>Time Kill Method.</b> 10µL (8 log <sub>10</sub> /mL) viral inoculum was added to 10µL test material and mixed. Following contact time, the mixture was neutralized by dilution in complete CMEM and plated on BSC-1 cells.	30 seconds	~7.8 log <sub>10</sub> virus surviving	
Vaccinia (vSIGK3)	Disinfectant	12% octylphen- oxypolyethoxy ethanol, 20% BZK	1:1250	Undiluted	Suspension	<b>Time Kill Method.</b> 10µL (8 log <sub>10</sub> /mL) viral inoculum was added to 10µL test material and mixed. Following contact time, the mixture was neutralized by dilution in complete CMEM and plated on BSC-1 cells.	60 seconds	~6.9 log <sub>10</sub> virus surviving	
Vaccinia (vSIGK3)	Disinfectant	12% octylphen- oxypolyethoxy ethanol, 20% BZK	1:1250	Virus infected cells	Suspension	<b>Time Kill Method.</b> 10µL (8 log <sub>10</sub> /mL) viral inoculum was added to 10µL test material and mixed. Following contact time, the mixture was neutralized by dilution in complete CMEM and plated on BSC-1 cells.	60 seconds	~7 log <sub>10</sub> virus surviving	
Vaccinia	Germicide	BZK 4	1:10000	Maint. media in EBSS	Suspension	<b>Time Kill Method.</b> 0.1mL viral inoculum was added to 0.9mL test material and mixed. Following contact time, the virus was grown in HeLa cells.	10 minutes	Inactivated virus	Klein and Deforest, 1963b

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Vaccinia	Disinfectant	2.680% BZK 2, 2.010% DDAC 2, 1.355% DDAC 1, 1.005% DDAC 3	1:128 in 400ppm hard water as CaCO <sub>3</sub>	5% FBS	Suspension	Not available	Not available	>5 log <sub>10</sub> reduction	The Brulin Corporation Undated

μL	microliter					EBSS	Earle's balanced salt solution
AOAC	Association of Official Analytical Chemists					FBS	Fetal bovine serum
BZK 1	Alkyl-(60% C <sub>14</sub> , 30% C <sub>16</sub> , 5% C <sub>12</sub> , 5% C <sub>18</sub> ) dimethyl benzyl ammonium chloride					FCS	Fetal calf serum
BZK 2	Alkyl-(50% C <sub>14</sub> , 40% C <sub>12</sub> , 10% C <sub>16</sub> ) dimethyl benzyl ammonium chloride					HBV	Hepatitis B virus
BZK 3	N-alkyl dimethyl benzyl ammonium chloride					HIV	Human immunodeficiency virus
BZK 4	Benzalkonium chloride: chain length distribution not specified					HPIV	Human parainfluenza virus
BZK 5	Alkyl-(67% C <sub>12</sub> , 25% C <sub>14</sub> , 7% C <sub>16</sub> , 1% C <sub>8</sub> , C <sub>10</sub> , C <sub>18</sub> ) dimethyl benzyl ammonium chloride					Maint.	Maintenance
CaCO <sub>3</sub>	Calcium carbonate					mL	milliliter
DDAC 1	didecyl dimethyl ammonium chloride					PBS	Phosphate buffered saline
DDAC 2	octyl decyl dimethyl ammonium chloride					ppm	parts per million
DDAC 3	dioctyl dimethyl ammonium chloride					R-saline	medium
DDAC 4	N-docyl-dimethyl ammonium chloride					TPB	Tryptose phosphate buffer
EBAC	Alkyl-(68% C <sub>12</sub> , 32% C <sub>14</sub> ) dimethyl ethylbenzyl ammonium chloride						