

Rapicide™ High-Level Disinfectant and Sterilant

Safety, Efficacy, and Microbiological Considerations



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PRODUCT DESCRIPTION

- Active Ingredient: Glutaraldehyde
- Concentration: 2.5%
- Minimum Recommended Concentration (MRC): 1.5% Glutaraldehyde
- Use/Reuse Period: Up to 28 days
- Sterilization Claim: 7 hours and 40 minutes @ 35°C
- High-Level Disinfection Claim: 5 minutes @ 35°C
- Dilution Required: None
- Activation Required: None
- Rust Inhibitor: Yes

PRODUCT DESCRIPTION (CON'T)

Rapicide is a ready-to-use liquid chemical germicide solution with an active ingredient of 2.5% w/v glutaraldehyde. The patented formulation (U.S. Pat. Reg. No. 4,748,219) includes a non-ionic detergent for improved wetting of surfaces.

Other ingredients include a corrosion inhibitor, silicone antifoaming agent, and dye.

Intended Use

Rapicide is labeled and intended for the high-level disinfection or sterilization of critical and semi-critical clean, heat-sensitive medical devices. Use is limited to legally marketed automated endoscope reprocessors that are capable of maintaining a constant disinfectant temperature of 35°C.

The product is intended for reuse up to 28 days at a constant temperature of 35°C, or until the glutaraldehyde concentration decreases to 1.5%, whichever comes first.

Rapicide glutaraldehyde concentration must be monitored with 3M Comply Cold SteriLog Glutaraldehyde Monitoring Strips, cat. no. 3983 by trained health care professionals.

Read and follow the directions for use and precautionary statements contained in the package insert before using.

SAFETY

- Rapicide is corrosive. Always wear proper eye protection and nitrile gloves when handling open containers. Avoid direct contact with eyes, skin, and clothing.
- In case of contact, flush eyes or skin with copious amounts of water for a minimum of 15 minutes. Seek immediate medical attention in case of eye contact.
- Avoid breathing fumes. Use Rapicide in well-ventilated areas only. Use only in an automated endoscope reprocessor with an effective vapor management system.
- Harmful if swallowed. In case of accidental ingestion, drink large quantities of water and call a physician immediately.
- Avoid contact with food. Do not store Rapicide near food.
- Refer to product insert and manufacturer instructions for reprocessing of medical devices in automated endoscopic reprocessing units.

Storage, Use and Disposal

Store Rapicide at controlled room temperature, between 15°C-25°C.

The contents of the container must be used immediately once opened. Discard any unused portion in an environmentally acceptable manner according to local, state, and federal regulations.

Do not reuse the empty container. Triple rinse the container with water and dispose of in an incinerator or a landfill approved for pesticide containers.

EFFICACY SUMMARY

Germicidal Activity of Rapicide as a Sterilant

Rapicide will sterilize with an exposure time of 7 hours and 40 minutes, at 35°C at a concentration equal to or greater than the minimum recommended concentration (MRC) of 1.5% glutaraldehyde. Rapicide may be reused for a maximum of 28 days, or until the glutaraldehyde concentration decreases to 1.5%, whichever comes first.

Germicidal Activity of Rapicide as a High-Level Disinfectant

Rapicide will high-level disinfect with an exposure time of 5 minutes at 35°C, at a concentration equal to or greater than the MRC of 1.5% glutaraldehyde. Rapicide may be reused for a maximum of 28 days, or until the glutaraldehyde concentration decreases to 1.5%, whichever comes first.

Efficacy Testing Summary

Rapicide was tested according to AOAC standards for microbiological tests for germicidal efficacy. Tests demonstrated sporicidal, bactericidal, fungicidal, tuberculocidal, and virucidal efficacy. The Rapicide used for all testing represented worst case stressed material at the MRC of 1.5% glutaraldehyde.

EFFICACY TEST DATA

“Worst Case Stressed” Rapicide

Rapicide stressed for 28 days at 35°C, following Environmental Protection Agency (EPA) re-use test standards was used as the worst case stressed solution for all anti-microbial efficacy tests. The re-use test included exposure to respiratory therapy equipment, inadvertent rinse water, microbial bioburden, and exposure time and temperature to simulate the most extreme conditions the disinfectant would encounter during use. The activity spectrum established by testing worst case stressed Rapicide is summarized in Table 1.

TABLE 1. Summary of Spectrum of Activity Testing

<i>Fungi</i>		
C. albicans	A. niger	T. mentagrophytes
<i>Bacteria</i>		
<i>Spores</i>		<i>Vegetative Organisms</i>
B. subtilis		S. aureus P. aeruginosa
C. sporogenes		S. chloreasuis M. bovis
<i>Viruses</i>		
<i>Non-enveloped</i>		<i>Enveloped</i>
Poliovirus Type 1		Herpes Simplex Type 1 Herpes Simplex Type 2
Adenovirus Type 2		Influenza Virus Type A HIV-1 Type 1

Sporicidal Activity Exposure Time/Sterilization Response Curve

A preliminary sterilization response curve was established by determining sporicidal activity as a function of exposure time.

Sixty porcelain cylinders and 60 silk suture loop carriers were labeled with *C. sporogenes* or *B. subtilis* spores according to the methods of the AOAC Sporidical Activity of Disinfectants Test. The carriers were then exposed to worst case stressed Rapicide at MRC for increasing exposure times at 35°C. Exposure times included 2 hours, 3 hours, 4 hours, 5 hours and 6 hours.

All spore-carrier combinations were sterilized within 3.0 hours at 35°C. Two cylinders tested positive for *C. sporogenes* per 30 total, with an exposure of 2 hours at 35°C.

These results support the sterilization contact times label claim of 7 hours and 40 minutes for Rapicide and indicate a substantial margin of safety for the claimed sterilization exposure. Refer to Figure 1 for test results.

Full AOAC Sporidical Activity of Disinfectants Test 966.04

Three lots of worst case stressed Rapicide at the MRC of 1.5% glutaraldehyde passed a full spectrum AOAC Sporidical Activity of Disinfectants Test 966.04 (720 carriers), with an exposure of 5.0 hrs at 35°C. This data indicates a substantial margin of safety for the 7 hour and 40 minute sterilization contact time label claim for Rapicide.

Confirmative AOAC Sporidical Activity of Disinfectants Test 966.04

Two lots of worst case stressed Rapicide passed an AOAC Sporidical Activity of Disinfectants Test 966.04, using 30 spore-labeled carriers per spore and carrier combinations, with an exposure of 5.0 hrs at 35°C.

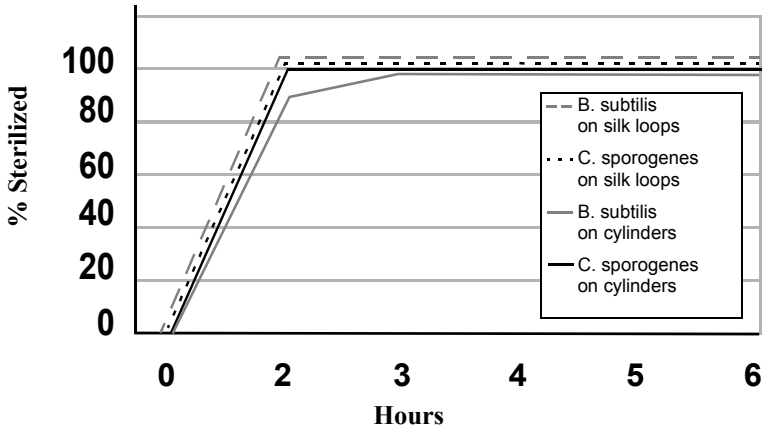
Quantitative Tuberculocidal Activity of Rapicide

Two lots of worst case stressed Rapicide at 35°C passed in a quantitative rate of kill test against *M. bovis var. BCG*. The Rapicide was found to kill $\geq 3.5 \times 10^7$ colony forming units (CFU) within 2.0 minutes.

As a control of resistance, the predicate Wavicide-01 Solution at 2.0% glutaraldehyde at 22°C required 45 minutes to kill the *M. bovis var BCG*.

This data supports the high-level disinfection contact time label claim for worst case stressed Rapicide at its MRC of 1.5% glutaraldehyde of 5 minutes at 35°C

FIGURE 1. Exposure Time/Sterilization Response Curve



AOAC Use Dilution Tests as a Function of Exposure Time and Glutaraldehyde Concentration—Vegetative Bacteria

Sixty cylinders labeled with *S. aureus* or *P. aeruginosa* according to AOAC Use Dilution Test standards were exposed to worst case stressed Rapicide at 1.5% glutaraldehyde. Exposure times included 2.5 minutes, 5.0 minutes, and 10.0 minutes at 35°C. The worst case stressed Rapicide at 1.5% glutaraldehyde passed the test within 2.5 minutes at 35°C.

Additionally, 60 bacteria-labeled cylinders were exposed to worst case stressed Rapicide further diluted to 1.0% glutaraldehyde at 35°C. Exposure times included 2.5 minutes, 5.0 minutes and 10.0 minutes. The worst case stressed Rapicide at 1.0% glutaraldehyde passed the test and disinfected all cylinders within 2.5 minutes at 35°C.

This data supports the high-level disinfection contact time label claim of 5.0 minutes at 35°C for Rapicide, with a substantial margin of safety in both exposure time and glutaraldehyde concentration.

AOAC Use Dilution Tests—Vegetative Bacteria

Cylinders labeled with *S. aureus*, *P. aeruginosa*, and *S. chloreasuis* according to AOAC Use Dilution Test standards were exposed to three lots of worst case stressed Rapicide at 1.5% glutaraldehyde, pH 6.1, for 5.0 minutes at 35°C.

The worst case stressed Rapicide eliminated all three bacterial species in each of the three lots to pass the AOAC Use Dilution Test within the high-level disinfection contact time label claim of 5.0 minutes at 35°C.

Fungicidal activity

T. mentagrophytes, *C. albicans*, and *A. niger* were exposed to worst case stressed Rapicide at 1.5% and diluted to 1.0% glutaraldehyde according to AOAC Fungicidal Activity of Disinfectants Test 955.17. Exposure times included 2.5 minutes, 5 minutes, 10 minutes and 15 minutes at 35°C. Worst case stressed Rapicide at 1.5% and 1.0% glutaraldehyde eliminated all three species within 2.5 minutes at 35°C.

This data supports the margin of safety in the high-level disinfection label claim of 5.0 minutes at 35°C for worst case stressed Rapicide for both exposure time and glutaraldehyde concentration for fungicidal activity.

Virucidal activity

Two lots of worst case stressed Rapicide at 1.5% glutaraldehyde and 1.0% glutaraldehyde were tested against viruses at 35°C for 5.0 minutes. Calf serum at 5% v/v was added to the virus cultures.

Both glutaraldehyde concentrations passed the test for Poliovirus type 1, Adenovirus type 2, Influenza virus type A2, Herpes simplex virus type 1 and type 2, and the Human Immunodeficiency virus (HIV) type 1 as required for a virucidal claim.

The tests at 1.0% glutaraldehyde indicate a margin of safety in the high-level disinfection claim of 5.0 minutes at 35°C for virucidal activity.

Simulated Use Tests

The interior channels of the insertion tube and umbilical tube of an Olympus-brand gastroscope, colonoscope, and sigmoidoscope were filled with $>10^6$ CFU of *M. bovis var. BCG* using a CW3 all channel irrigator. The endoscopes were dried for 30 minutes at ambient temperatures then placed into a MediVators automatic endoscope reprocessor set for manual operation.

Rapicide diluted with synthetic hard water to 1.5% glutaraldehyde filled the channels and flooded the endoscopes for 5.0 minutes at 35°C. Without any pre-rinse or post-rinse, the endoscope channels were tested twice for surviving CFU of *M. bovis var. BCG*.

All endoscopes showed a 10^6 CFU or greater reduction after exposure to Rapicide.

This data supports high-level disinfection contact time claim for Rapicide at 1.5% glutaraldehyde with an exposure of 5.0 minutes at 35°C under extreme (no pre-or post-rinses) simulated laboratory use conditions, killing $\geq 10^6$ CFU of *M. bovis var. BCG*.

Clinical In-Use Tests of Rapicide

Rapicide was tested at a busy endoscopy clinic. Immediately after use with patients, 100 ml of sterile physiological saline solution containing 1.0% sodium bisulfite was drawn through the insertion tube and umbilical tube channels of Pentax-brand gastroscopes and colonoscopes.

The samples were measured for the number of clinical (unspecified) aerobic bacteria within the endoscope channels, and also simulated a pre-rinse. The endoscopes were then immersed in Rapicide at 1.5% glutaraldehyde, pH 6.1, at 35°C filling all interior channels for an exposure time of 5.0 minutes. The channels were again measured for surviving wild type bacteria.

Three gastroscopes and three colonoscopes were found to be contaminated with 3.5×10^3 CFU to 1.0×10^7 CFU of bacteria. Zero live bacteria were recovered after exposure to Rapicide for 5.0 minutes at 35°C, the high-level disinfection contact time label claim for Rapicide.

COMPATIBILITY

Automated Endoscope Reprocessor Compatibility

Rapicide was evaluated in various MediVators Automated Endoscope Reprocessor (AER) models. Tests included temperature stability, vapor exposure, residual disinfectant, use dilution, foam and critical component compatibility.

Temperature Stability Testing: MediVators AER basin and reservoir temperature profiles were measured with a combination of temperature probes and thermocouples.

All four MediVators AER models showed that a reservoir thermally stabilized per the manufacturer instructions at the start of the cycle will maintain the disinfectant temperature in the basin at or above the required high-level disinfection temperature of 35°C throughout a five minute high-level disinfection cycle.

TABLE 2. Average Temperature Variations Between AER Models¹

<i>Reprocessor Type</i>	<i>MV1</i>	<i>MV2</i>	<i>SSD</i>	<i>DSD-A</i>	<i>DSD-B</i>
Average temperature difference between reservoir and basin	1.6°C	1.9°C	1.4°C	1.6°C	1.4°C
Average machine to machine temperature variation in the basin	0.9°C	0.9°C	1.1°C	1.0°C	1.1°C
Average machine to machine temperature variation in the reservoir	1.2°C	0.5°C	0.3°C	0.6°C	0.6°C

¹ Average is taken from testing three machines, five cycles per machine. The reservoir temperatures were always higher than the basin temperatures.

Vapor Exposure Testing: The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a glutaraldehyde ceiling exposure limit of 0.05 ppm for an eight-hour time weighted average.

Rapicide vapor measurements were determined in a test cell with air flow controlled to ten exchanges per hour. All four MediVators AER models with Rapicide showed glutaraldehyde vapor levels in the operator-breathing zone below the recommended exposure limit of 0.05 ppm.

TABLE 3. Vapor Exposure Comparison Between AER Models

<i>AER Model</i>	<i>MV1</i>	<i>MV2</i>	<i>SSD-100</i>	<i>DSD-91E</i>
8 hour average ¹	0.005 ppm	0.004 ppm	0.007 ppm	0.008 ppm
15 minute ² average	≤0.02 ppm	≤0.02 ppm	≤0.02 ppm	≤0.02 ppm

1 Indicates an eight-hour test with badges in a fixed location 52” from the floor and 36” from the disinfectant upper basin.

2 Indicates a fifteen-minute test for glutaraldehyde vapor monitoring results reported by Advanced Chemical Sensor, Inc. as less than or equal to 0.02 ppm (detection limit of monitor for 15 minute exposure). Badge location is the same as in footnote 1.

Residual Disinfectant Testing: Olympus and Pentax-brand flexible endoscopes were reprocessed with Rapicide at 35°C in various MediVators AER models. Each model tested showed a significant reduction in the amount of glutaraldehyde residuals between the first and second rinse. The final endoscope residuals were lower than residuals found in manual reprocessing. Refer to Table 4 for test results.

TABLE 4. Residual Disinfectant Comparison Between Methods/Models

<i>Disinfectant Method</i>	<i>Rinse #1</i>	<i>Rinse #2</i>	<i>Extract</i>
Manual reprocessing method	220.6µg/ml	6.5µg/ml	22.2µg/ml
MV1 average	74.0µg/ml	2.1µg/ml	<1.0µg/ml
MV2 average	104.2µg/ml	8.7µg/ml	8.6µg/ml
DSD-91E average	78.2µg/ml	5.4µg/ml	<1.0µg/ml
SSD-100 average	23.0µg/ml	2.9µg/ml	5.0µg/ml

Use Dilution Testing: Use dilution of Rapicide with 3M Comply Cold SteriLog Glutaraldehyde Monitoring Strips, cat. no. 3983 was evaluated in various MediVators AER models. The disinfectant reservoir was thermally stabilized per manufacturer instructions. 3M Comply Cold SteriLog Glutaraldehyde Monitoring Strips, cat. no. 3983 were then immersed into Rapicide in the disinfectant basin during the disinfectant cycle.

Monitoring strip color change was evaluated at five minutes after exposure to determine if Rapicide was at or above the 1.5% glutaraldehyde MRC limit.

The number of effective uses of Rapicide ranged from 61 cycles to 76 cycles for the AER models studied. In a clinical setting, variability in the bioburden level, pre-cleaning procedure and the type of device being reprocessed may impact the actual MRC failure point, reached with fewer or more cycles than the test data indicates. Refer to Table 5 for test results.

TABLE 5. Effective Cycles by Model

<i>Reprocessor Type</i>	<i>MV1</i>	<i>MV2</i>	<i>SSD-100</i>	<i>DSD-91E</i>
Cycles until MRC test failure	70	61	76	73 ¹

¹ Station A and B both had cycle monitoring strips fail at 73 cycles for DSD-91E

Foam Testing: Rapicide was evaluated in various MediVators AER models for disinfectant foam which might result in misleading error messages, disinfectant reservoir overflow or residual basin foam. All MediVators AER models with Rapicide met preset acceptance criteria. The results shown below for cycle 10 were identical for every cycle, to cycle 90.

TABLE 6. Presence of Foam at Cycle 10 Comparison by Model

<i>Reprocessor Type</i>	<i>MV1</i>	<i>MV2</i>	<i>SSD-100</i>	<i>DSD-91E¹</i>
Foam	Minimal	Minimal	Minimal	Minimal
Height	<0.25in	<0.25in	0.25in	0.25in
Error	No	No	No	No

¹ For DSD-91E, Station A and Station B data is combined for this table

Critical Components Testing: Representative critical components were selected from various MediVators AER models. Components included those directly contacting disinfectant and components also known to be potentially susceptible to various liquid chemical germicides.

All components were immersed in Rapicide for four weeks, approximating more than 6,000 cycles with five minute exposure times. All components passed the test criteria with no signs of corrosion, deterioration, discoloration or swelling. Refer to Table 7 for test results.

TABLE 7. Component Compatibility Four Week Test (10/10/00-11/17/00)

<i>Components and quantity</i>	<i>Week 1</i>	<i>Week 2</i>	<i>Week 3</i>	<i>Week 4</i>
(1) 3/4" plunger housing, top removed ¹	Pass	Pass	Pass	Pass
(1) 3/4" plunger ¹	Pass	Pass	Pass	Pass
(1) 3/4" spring ¹	Pass	Pass	Pass	Pass
(2) housing O-rings ¹	Pass	Pass	Pass	Pass
(1) 1/4" plunger seal ²	Pass	Pass	Pass	Pass
(1) 1/4" O-ring ²	Pass	Pass	Pass	Pass
(1) 1/4" spring ²	Pass	Pass	Pass	Pass
(3) pump seals ³	Pass	Pass	Pass	Pass

1 Component common to SSD-100, DSD-91E, MV-1 and MV-2

2 Component common to DSD-91E only

3 Component common to SSD-100 only

Chemical indicators of glutaraldehyde concentration: A stressed lot of Rapicide was further diluted with synthetic hard water to percentages of 1.8, 1.7, 1.6, 1.5, 1.4, and 1.3% glutaraldehyde.

Fifty 3M Comply Cold SteriLog Glutaraldehyde Monitoring Strips, Cat. No. 3983 designed to fail at glutaraldehyde concentrations of $\leq 1.5\%$ were used to measure the glutaraldehyde concentrations of Rapicide at 35°C .

- 100% of the monitors tested indicated fail (discard solution) at glutaraldehyde concentrations $\leq 1.5\%$ at 35°C .
- 28% to 98% of the monitors indicated discard solution at 1.7% or 1.6% glutaraldehyde at 35°C .
- 96% of the monitors indicated that glutaraldehyde concentration was $>1.5\%$ when the glutaraldehyde concentration was in fact 1.8% at 35°C .

This test data concludes 3M Comply Cold SteriLog Glutaraldehyde Monitoring Strips, cat. no. 3983 are a legally marketed monitor, accurately indicating to discard the Rapicide at a $\leq 1.5\%$ concentration of glutaraldehyde with a substantial margin of safety.

Material Compatibility

Rapicide has been tested for material compatibility and is determined to be compatible with the materials listed in Table 8.

TABLE 8. Material Compatibility

<i>Plastics</i>	<i>Metals</i>	<i>Elastomers</i>
Polyethylene ²	416 Stainless Steel ¹	Neoprene ¹
Polyvinyl Chloride ¹	303 Stainless Steel ¹	Silicone rubber ¹
Teflon ¹	Chrome plate ¹	Red natural rubber ¹
Polyurethane ¹	316 Stainless Steel ¹	
Acrylonitrile-butadienestyrene ¹	Anodized black aluminum ¹	
Nylon ²		
Polypropylene ²		
Polyester ¹		
Polycarbonate ¹		
Polysulfone ¹		

1 Satisfactory test results after 532 hours of soaking at 35°C and 20 cycles of alternate immersion in Rapicide.

2 Tinting observed after 532 hours of soaking at 35°C and 20 cycles of alternate immersion in Rapicide.

Note: Soak time of 532 hours at 35°C represents over 6000 individual high-level disinfectant 5 minute exposure cycles. Refer to reusable device labeling for additional instructions, or contact the device manufacturer.



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