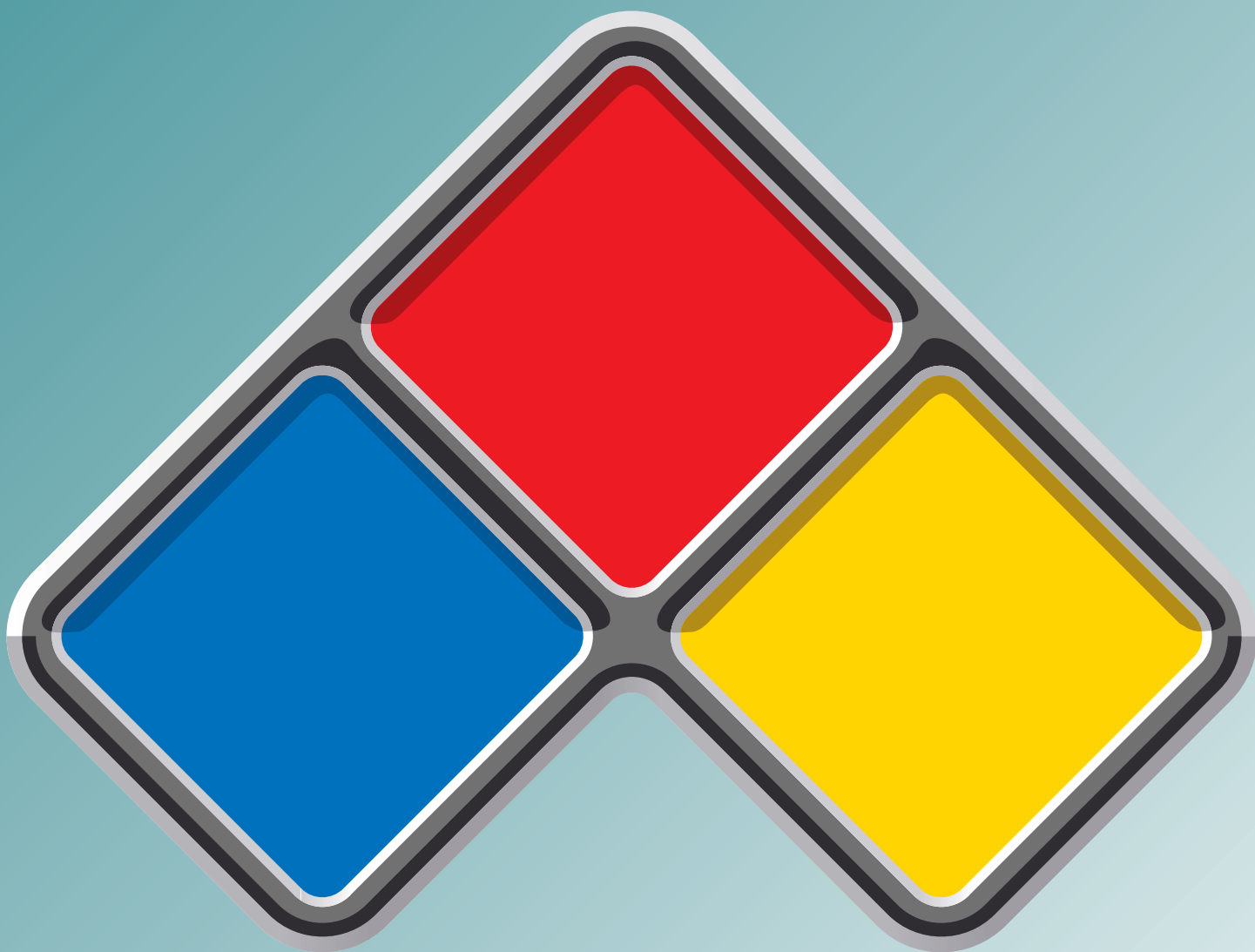




# GLUTARALDEHYDE

## *Safe Handling and Storage Guide*



*2003 Revision*

***Important:*** The Dow Chemical Company, has compiled the information contained herein from what it believes are authoritative sources and believes that it is accurate and factual as of the date printed. It is offered solely as a convenience to its customers and is intended only as a guide concerning the products mentioned. Since the user's product formulation, specific use application, and conditions of use are beyond Dow's control, Dow makes no warranty or representation regarding the results that may be obtained by the user. It shall be the responsibility of the user to determine the suitability of any products mentioned for the user's specific application. This information is not to be taken as a warranty or representation for which Dow assumes legal responsibility nor as permission to practice any patented invention without a license.

No chemical should be used as or in a food, drug, medical device, or cosmetic, or in a product or process in which it may contact a food, drug, or cosmetic, until the user has determined the safety and legality of the use. Since government requirements and use conditions are subject to change, it is the user's responsibility to determine that the information contained herein is appropriate under current, applicable laws and regulations.

Dow requests that the customer study this product information booklet and current Material Safety Data Sheets and become aware of product characteristics. The customer should furnish the information in this product information booklet to its employees, contractors, and customers for the products and request such contractors and customers for the products to notify their employees and customers of the information in this booklet.

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Dow offers a broad line of glutaraldehyde-based solutions, which are useful in a wide range of industrial and microbiocidal applications. They are produced and sold as aqueous solutions of glutaraldehyde, a linear, five-carbon dialdehyde, containing up to 50 percent active by weight.

Health studies of our glutaraldehyde workers have shown that good work practices prevent allergic skin reactions, respiratory, or eye problems attributable to glutaraldehyde. Employees at our production and blending facilities around the world follow specific procedures that help avoid exposure to the product.

This booklet describes environmentally acceptable techniques for the safe handling, storage, and disposal of glutaraldehyde-based solutions. For additional information on products, specifications, and Material Safety Data Sheets, contact our Customer Information Office.

## ***Glutaraldehyde Identification***

<i>Common Name</i> .....	Glutaraldehyde
<i>Chemical Name</i> .....	1,5-Pentanedial
<i>Chemical Family</i> .....	Aldehyde
<i>CAS Registry Number</i> .....	111-30-8
<i>Molecular Formula</i> .....	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>
<i>Molecular Weight</i> .....	100.12

## SAFETY CONSIDERATIONS

### **Glutaraldehyde Stability**

Glutaraldehyde-based solutions are stable under normal storage conditions. Although heating the product will result in color formation and slow polymer formation, it does not represent a safety concern. However, if water is evaporated from aqueous glutaraldehyde solutions, the residual material will rapidly polymerize in a non-hazardous reaction producing residue that will burn. In case of a fire, carbon dioxide, dry chemical, alcohol-type, or universal-type foams, applied according to the manufacturers' recommended technique, are suitable extinguishers. Self-contained breathing apparatus should be available to fire fighters since glutaraldehyde vapor is irritating at very low concentrations.

Contamination of concentrated solutions of glutaraldehyde with strongly acidic or alkaline impurities can result in exothermic polymerization of the contained glutaraldehyde via aldol condensation reactions. If this occurs, addition of water to dilute the solution is recommended.

### **Liquid and Vapor Contact**

When handling glutaraldehyde-based solutions, avoid contact with the liquid and inhalation of the vapor. Protective gloves (see page 3), splash-proof monogoggles, or both safety glasses with side shields and a wraparound full-face shield, and protective clothing should be worn. Many face shields alone do not offer total protection against eye contamination, and their use should be considered an adjunct to protect facial skin. Eye baths and shower facilities should be provided.

### **Inhalation<sup>(1)</sup>**

Exposure to glutaraldehyde vapor above 0.3 ppmv will cause irritation to the respiratory tract. These symptoms are temporary. However, there have been a few reports of asthmatic-like symptoms and signs in those with hyper-reactive bronchioles. The currently available information is inconclusive as to whether the asthma is due to respiratory sensitization or a simple irritant-induced effect.

If the product is handled in closed equipment, general (mechanical) room ventilation should be satisfactory. Vapor levels should not exceed the recommended or stipulated Threshold Limit Value (TLV)<sup>(2)</sup> or Occupational Exposure Limit (OEL)<sup>(2)</sup> in the country of use. Glutaraldehyde has a recognizable odor with a detection threshold of < 1 ppbv. The threshold for odor perception is more than 100 times below the Threshold Limit Value (TLV) of 0.05 ppmv recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). Thus, because human beings perceive glutaraldehyde in air well below the air concentration that causes irritation to mucous membranes, the smell of glutaraldehyde may have no health significance. If, however, the odor of glutaraldehyde is accompanied by irritation to the nose and eyes, then the ceiling limit may have been exceeded, and improved ventilation or respiratory protection may be required.

Because glutaraldehyde vapor exposure limits are defined differently from country to country, we recommend maintaining levels at or below the applicable requirements of your locale. In the absence of any requirements, we currently recommend maintaining vapor exposure levels at or below 0.1 parts per million ceiling.

If the odor of glutaraldehyde persists in the workplace, industrial hygiene studies should be employed to form a practicable basis for the design of both engineered and personal protection safeguards against potential overexposure.

In areas of high glutaraldehyde vapor concentration, self-contained breathing apparatus is recommended. For temporary service in areas of low vapor concentrations of glutaraldehyde, a full-face, cartridge-type respirator may be useful. Specifically, Dow has experienced satisfactory performance with the use of Mine Safety Appliances' organic vapor cartridges (Part #464031) and an "Ultra Twin" Respirator<sup>(4)</sup>. If, in addition to vapor, exposure to aerosols and/or spray mists is possible, the respirator should be equipped with a pre-filter. This is recommended because the capacity of the cartridge to protect against the breakthrough of vapors will be depleted much more rapidly if it becomes wetted with liquid droplets. (Note: this product in its undiluted form must not be used in a spray or aerosol application.)

If a full-face, cartridge-type respirator is used, instruct personnel to leave the work area and replace the cartridges if they begin to detect the odor of glutaraldehyde. If odor continues to be detected with fresh cartridges, the mask may not be fitted properly, or the mask may be defective, or the concentration of glutaraldehyde may be too high for this type of mask and the use of a self-contained breathing apparatus is required.

Concentrated solutions of glutaraldehyde-based solutions should be handled at or near room temperature to avoid excessive vapor. If glutaraldehyde solutions must be added to warm solutions, addition via a dip tube placed below the surface is recommended to minimize vapor development.

## Skin Contact<sup>(1)</sup>

Glutaraldehyde can cause irritation if in contact with the skin, and in a small percentage of exposed individuals, skin sensitization has been reported. Glutaraldehyde at concentrations of 10 percent and less is known not to be absorbed across the skin in harmful amounts.

Aqueous glutaraldehyde solutions containing 45% and greater may be corrosive to the skin. Prolonged contact with concentrations higher than 5% cause mild-to-moderate local redness and swelling. Low concentrations of glutaraldehyde, e.g., 2-4%, may cause minor irritation with local itching and possible slight local redness. At 0.2%, less than 3% of tested human volunteers had barely perceptible redness of the skin. Concentrations of glutaraldehyde below 0.1%, typical of most industrial applications, have not demonstrated allergic skin reaction.

To prevent skin contact with glutaraldehyde, protective gloves, a wrap-around full-face shield, and protective clothing should be worn. (**Caution:** to prevent eye contact, it is essential to follow the safety information outlined in "Precautions" on page 5.)

## Protective Gloves<sup>(5)</sup>

A variety of commercially available protective gloves were evaluated for permeability of aqueous, non-formulated glutaraldehyde solutions according to the American Society for Testing Materials F739-81 Permeation Test Protocol. Test results indicated that nitrile and butyl rubber are suitable for use with up to 50% glutaraldehyde. While polyethylene gloves are acceptable for use with low concentrations of glutaraldehyde ( $\leq 3.4\%$ ), they are not recommended for use with higher concentrations of glutaraldehyde (15–50%). Neoprene and polyvinyl chloride (PVC) gloves, although acceptable for other applications, are not recommended for use with glutaraldehyde because they retain or absorb glutaraldehyde.

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It is important that the proper size, length, type, and quality of glove be worn when working with glutaraldehyde. Gloves should be long enough to extend up the arm to protect the forearm or clothing from splashes and seepage. Prior to use, gloves should be inspected for tears or holes. Do not use an imperfect glove.

Glutaraldehyde in occluded contact with skin is more likely to cause irritation. Thus, if it is suspected that glutaraldehyde has seeped through or splashed between the glove and the skin, remove the glove immediately and wash thoroughly before putting on a new pair of gloves.

Using the proper type of glove in the correct manner is important for adequate hand protection. Penetration of glutaraldehyde through a glove is a function of both chemical compatibility and quality of the glove, and hence, generalizations cannot be made from one manufacturer to another. Always check, and comply with manufacturer recommendation on the suitability of a glove for its intended use.

## **Eye Contact<sup>(1)</sup>**

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### ***Liquid Contact With Eyes***

Glutaraldehyde solutions of 2% and greater will produce severe, irreversible eye injury.

Solutions of 1% glutaraldehyde in water, if splashed on the eye, can cause moderate-to-severe irritation to the eye, which is experienced as discomfort or pain, excess blinking, and tear production, with marked excess redness and swelling of the conjunctiva. Contact can cause minor-to-severe corneal injury that may persist if not adequately and promptly treated.

Studies have shown that the lowest concentration causing minor corneal injury and conjunctival irritation was 0.25% glutaraldehyde, and the no-effect concentration was 0.1%.

### ***Vapor Contact With Eyes***

Glutaraldehyde has a peripheral sensory irritant effect, *i.e.*, it is capable of reversibly interacting with sensory nerve-endings in exposed body surfaces such as the skin or covering/lining membranes of the eye and respiratory tract. As a result, there is a local sensation or discomfort where contact with the vapor occurs, together with the development of certain reflex effects. For example, exposure of the eye to airborne glutaraldehyde causes a stinging sensation in the eye accompanied by excess tearing and blinking. This is an entirely

normal biological response to sensory irritant materials and gives warning of exposure to such materials together with some degree of protection; both blinking and excess tearing will limit exposure.

Furthermore, such effects are generally experienced at concentrations below those producing any inflammation or injury. For glutaraldehyde, a study with a volunteer panel has shown that for the eyes the threshold for sensory irritation by vapor exposure is 0.3 ppmv for humans. [The odor threshold for glutaraldehyde is <1 ppbv and is the first indication that glutaraldehyde vapor is escaping into the workplace. This is an early indicator that attention should be given to improving ventilation or workplace practices.]

## Precautions

- ◆ Always wear splashproof monogoggles, or both safety glasses with side shields and a wraparound full-face shield, when working around glutaraldehyde solutions. Many face shields alone do not offer total protection against eye contamination, and their use should be considered an adjunct to protect facial skin.
- ◆ If a glutaraldehyde solution comes in contact with the eyes, wash immediately and continuously with flowing water for at least 30 minutes. Remove contact lenses after the first 5 minutes and continue washing. Obtain prompt medical consultation preferably from an ophthalmologist.
- ◆ Suitable eyewash units should be available in all glutaraldehyde usage locations.
- ◆ Glutaraldehyde solutions should be used only in properly ventilated areas in which atmospheric glutaraldehyde vapor concentrations are maintained below the prescribed or recommended Threshold Limit Value (TLV) or Occupational Exposure Limit (OEL). Vapor exposure levels should be monitored to assure healthy and safe working conditions as well as compliance with applicable governmental requirements. Caution should be exercised and additional monitoring is recommended when there is a major change in operating protocol, workplace ventilation systems, workload, or any complaint of eye discomfort. Immediate action should be taken if the vapor level is above the TLV or OEL.



# SPILLS, DISPOSAL & DEACTIVATION OF GLUTARALDEHYDE

## Spills

Prompt and appropriate attention to drips, splashes, and spills is important to reduce the potential for unnecessary exposure to glutaraldehyde, especially to vapor concentrations above the applicable TLV or OEL.

Avoid making contact with spilled material, taking care not to step in spills since glutaraldehyde will be absorbed by most shoes. When cleaning up a spill, always wear the correct protective equipment, consisting of splashproof monogoggles, or both safety glasses with side shields and a wraparound full-face shield, appropriate gloves (see Protective Gloves, page 3), and protective clothing. A self-contained breathing apparatus or respirator and absorbents may be necessary, depending on the size of the spill and the adequacy of ventilation.

Consult local regulatory requirements for additional guidance on spill prevention and cleanup.

### Spill Containment Plan

A spill containment plan for glutaraldehyde should be in place and should include easy access to equipment for cleaning up a spill, as well as procedures for alerting personnel, avoiding glutaraldehyde contact, and, if necessary, evacuating non-essential personnel until the spill has been neutralized and disposed of. Type of ventilation, air turnover rate, the size and temperature of the room, and the quantity spilled are important considerations.

### Cleanup of Spills

#### Small Spills

To clean up small spills, wear the correct protective equipment and cover the liquid with absorbent material. Collect and seal the material in polyethylene bags and place in a drum for transit to an approved disposal site.

Dirt that has absorbed the spilled material should also be collected and similarly discarded.

The remaining spilled material may be rinsed away with water to reduce odor. However, it is important to ensure that the rinsate is discharged into a municipal or industrial sewer, not into a natural waterway.

#### Large Spills

Large spills that cause nasal and respiratory irritation indicate that the area should be evacuated and cleaned up by a trained team. The appropriate safety and governmental personnel should be notified immediately.

If tearing of the eyes and nasal or respiratory irritation occur with a spill, then the room ventilation is inadequate to handle the spill. The room should be vacated immediately until a team equipped to handle a larger spill is on the scene.

Personnel cleaning up a larger spill should be trained and equipped with a self-contained breathing apparatus, or, if not available, an officially approved or certified full face respirator equipped with an organic vapor cartridge, gloves, and clothing impervious to glutaraldehyde, including rubber boots or shoe protection.

Pour an appropriate deactivation compound (see page 8) into the spilled glutaraldehyde. Collect the neutralized liquid and, if appropriate, flush it down the drain with large amounts of fresh water. Depending on the quantity spilled, absorbents may be needed. Large spills should be contained and deactivated before disposal.

Although the methods listed below will deactivate glutaraldehyde, there may be other components present in a particular formulation that must also be considered before effective and safe cleanup is initiated. Please consult the manufacturer of the other chemical components in the formulation for further details and precautions. (See also page 18 for spill control of bulk storage tanks.)



## **Disposal**

### **Disposal of Concentrate**

Glutaraldehyde-based solutions should not be discharged into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with local regulatory procedures [e.g., U.S. National Pollutant Discharge Elimination Systems (NPDES) permit]. Do not discharge effluent containing glutaraldehyde to sewer systems without previously notifying the local sewage treatment plant authority. For guidance, contact your local water board, regional office of the Environmental Protection Agency, or appropriate regulatory authority.

In unusual circumstances, when you have large quantities of concentrated glutaraldehyde to dispose of (those containing greater than 5% active), high-temperature incineration is an acceptable practice. Under these conditions, glutaraldehyde burns cleanly to carbon dioxide and water.

### **Disposal of Diluted Product**

Two environmentally acceptable methods exist for disposing of solutions of glutaraldehyde. The simpler method involves further dilution to an essentially nonmicrobiocidal concentration (less than 5 ppm active) in order to allow the glutaraldehyde to biodegrade. The second procedure requires chemical inactivation prior to natural disposal (see Chemical Deactivation, page 8). When disposing of the diluted glutaraldehyde, consult local authorities for regulations. It is not advisable to discharge diluted glutaraldehyde into septic systems.

### **Bio-oxidation of Glutaraldehyde**

In the laboratory, the potential rate at which a chemical can degrade is often measured by the Biochemical Oxygen Demand (BOD) test. This standard test involves exposing a test material to an unacclimated sewage seed and measuring the oxygen demand of the system. Calculations of percent bio-oxidation are correlated to the amount of oxygen required to degrade the chemical completely to carbon dioxide and water. Glutaraldehyde exhibits a Chemical Oxygen Demand (COD) of 1.88 mg O<sub>2</sub>, per mg active, as compared to a Theoretical Oxygen Demand (ThOD) of 1.92 mg O<sub>2</sub>, per mg active. In a standard BOD test<sup>(7)</sup>, more than 50% of glutaraldehyde was degraded in less than five days.

The effect of glutaraldehyde on the respiration and growth of sewage microorganisms was assessed in two separate tests. In the OECD 209 respiration inhibition test, the EC-50 concentration (i.e., the concentration that reduces the respiration rate of the bacteria by 50%) after a 30-minute contact time was determined to be greater than 50 ppm. The No Observed Effect Concentration (NOEC) was determined to be 16 ppm in the same study. These results are consistent with a separate study that determined the EC-50 values for inhibition of bacterial growth after a 16 hour contact time – to be 25 ppm – for sewage microorganisms and 17 ppm for a commercial product containing a broad spectrum of bacteria. The NOEC for glutaraldehyde in this study was 5 ppm.

## Chemical Deactivation

If dilution to below 5 ppm active is not practical, glutaraldehyde can be deactivated chemically by adding a suitable amount of alkalinizing or reducing agents. Two options are available, depending on the concentration of glutaraldehyde to be deactivated.

### With Sodium Bisulfite ( $\text{NaHSO}_3$ )

An effective chemical method that can be used to deactivate concentrations of glutaraldehyde (up to 5%) is by addition of sodium bisulfite ( $\text{NaHSO}_3$ ). In order to assure rapid, complete deactivation, it is recommended that 2–3 parts (by weight) of  $\text{NaHSO}_3$  be added per part of active glutaraldehyde. Addition of 2-3 parts  $\text{NaHSO}_3$  will rapidly reduce the concentration of glutaraldehyde in solution to less than 2 ppm active within five minutes at room temperature. The remaining solution can then be disposed of by appropriate means.

The following table illustrates the amounts of  $\text{NaHSO}_3$  needed for different concentrations of glutaraldehyde.

Water Volume, gallon (L)	Glutaraldehyde Active Level, ppm	$\text{NaHSO}_3$ Required, ounce (g)
100 (380)	20	0.53–0.8 (15–23)
500 (1900)	100	13.3–20 (380–570)
5 (19)	20,000 (2%)	26.7–40 (760–1140)

*Note:  $\text{NaHSO}_3$  reacts readily with other aldehydes and ketones. If other aldehydes or ketones are present, more  $\text{NaHSO}_3$  may be necessary for complete deactivation. There may be other components present in your solution that will not be deactivated by  $\text{NaHSO}_3$ . For a complete summary of the chemistry and toxicology associated with  $\text{NaHSO}_3$  deactivation of glutaraldehyde, see reference 6, page 9.*

### With Sodium Hydroxide (Caustic Soda)

Glutaraldehyde concentrations up to 2% active may be deactivated by the addition of aqueous sodium hydroxide (caustic soda). Adding a sufficient amount of sodium hydroxide solution to maintain a pH of 12 will reduce the concentration of glutaraldehyde to approximately 20 ppm or less within 8 hours at room temperature. Maintaining the pH at 12 or higher is critical, since a lower pH will result in a significantly slower deactivation of glutaraldehyde. The treated solutions, which now contain a low level of residual glutaraldehyde, should be returned to neutral pH by the careful addition of an inorganic acid (e.g., hydrochloric acid) before disposal by appropriate means.

## REFERENCES

- (1) For more detailed toxicology information refer to: "Toxicology of Glutaraldehyde: Review of Studies and Human Health Effects," revised 1995 and available from The Dow Chemical Company. Prepared by Bryan Ballantyne, M.D., D.Sc., Ph.D., former Director of Applied Toxicology for Union Carbide.
- (2) The Threshold Limit Value (TLV) refers to the time-weighted average concentration for a conventional 8-hour workday and a 40-hour workweek, to which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effect. 2002 TLVs and BEIs, Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices, 2002, ACGIH.

The Occupational Exposure Limit (OEL) refers to the airborne concentration of a substance that should not be exceeded. OELs for glutaraldehyde vary among countries but are generally in the 0.05 to 0.2 ppmv range. OELs are sometimes expressed in mg/liter. For glutaraldehyde, the value in mg/liter divided by 4 gives the value in ppmv. Note: This value is a ceiling limit which should never be exceeded.

For many substances, the TLV or OEL is expressed as a time-weighted average over an eight-hour working day (TWA<sub>8</sub>). For others, it is expressed as a TWA<sub>8</sub> qualified by a Short-Term Exposure Limit (STEL), which is a 15-minute TWA that should not be exceeded at any time. Exposures above the TWA<sub>8</sub> up to the STEL should be no longer than 15 minutes, should not occur more than four times a day, and there should be at least 60 minutes between successive exposures in this range. For glutaraldehyde, the TLV or OEL is often expressed as a Ceiling (C) value, which is the concentration that should not be exceeded during any part of the working exposure. The ACGIH TLV-C value for glutaraldehyde is 0.05 ppmv. There is no associated qualifying TWA<sub>8</sub>, but sampling may be over a 15-minute period.
- (3) When a workplace exposure guideline (TLV or OEL) has not been established, or if it is believed that the recommended guideline is inappropriate, Dow has a formal review process to establish a value to be applied to its workplaces; this is referred to as an Industrial Hygiene Guideline (IHG). This is a compliance limit, applicable worldwide within Dow. IHGs are reviewed periodically to ensure that they provide adequate protection. IHGs are expressed as a TWA<sub>8</sub>, sometimes qualified by a STEL, or as a Ceiling value.
- (4) Mine Safety Appliances Co., 121 Gamma Drive, Pittsburgh, PA 15238-2937.  
Tel: 1-800-MSA-2222, 412-967-3000.  
Internet: [www.msanet.com](http://www.msanet.com).
- (5) Jordan, S.L.P.; Stowers, M.F.; Trawick, E.G.; Theis, A.B. "Glutaraldehyde Permeation: Choosing the Proper Glove," *Am. J. Infect. Control*, 1996, 24: 67-69.
- (6) Jordan, S.L.P. *et al.* 1996, "Inactivation of Glutaraldehyde by Reaction with Sodium Bisulfite," *J. Tox. Envir. Health*, 47: 299-309.
- (7) *Standard Methods for the Examination of Water and Waste Water*, 14th ed., American Public Health Assoc., 1976, Parts 507 and 508.

# PROCEDURES FOR SAFE HANDLING & STORAGE

Glutaraldehyde-based solutions are shipped by barge, deck tank, tank truck, intermediate-sized bulk container (IBC), drum, and other smaller containers. The handling procedures and precautions noted in the section on Safety and Environmental Considerations should be followed for all shipping methods.

## Personnel Training

When working with any chemical, including glutaraldehyde, it is important that personnel be trained in the properties of the material, possible adverse effects resulting from overexposure, and use and procedures appropriate for the chemical. Therefore, a formal training program should be in place in which new users are educated in proper procedures and experienced users are informed of issues regarding glutaraldehyde use.

With suitable training and understanding, workers can minimize their own exposure by following basic work guidelines. In addition, access to glutaraldehyde solutions should be limited to those trained in its use.

Employees should be aware of safety procedures that go into effect in case of a spill. All employees should be familiar with the Material Safety Data Sheet (MSDS) that comes with each product. This sheet should be accessible to all users. It contains information regarding emergency medical treatment and spill cleanup. Accessibility is particularly important to physicians who may be treating acute overexposure (*e.g.*, a splash in the eye).

To minimize contact with glutaraldehyde solutions, tight-fitting lids should be used on all storage containers. These lids should be in place at all times. When mixing and pouring solutions, care should be taken to minimize splashes and to reduce accidental spills.

## Drums

### Handling and Storage

When a truckload of drums is received, ventilate the truck before entering to remove any potentially irritating vapors of glutaraldehyde. All personnel handling drums should wear protective gloves, splashproof monogoggles, or both safety glasses with side shields and a wraparound full-face shield, and protective clothing. A well-drained concrete pad is recommended for the storage area. Preferably, the storage area should be indoors or in a shaded area to avoid temperature-related quality problems and should be well ventilated.

### Emptying Drums

Before drums are opened, they should be at or below room temperature. This will minimize personnel exposure and air emissions.

When removing plugs or emptying drums, the operator should wear protective gloves, splashproof monogoggles, or both safety glasses with side shields and a wraparound full-face shield, and protective clothing. A bung or plug wrench should be used. The operator should place the bung-end up, stand to one side, and face away during the operation. After the plug starts to loosen, it should not be given more than one full turn. Since drum contents may be under pressure, care must be exercised to prevent product splashing. If internal pressure exists, it should be allowed to escape to the atmosphere. Avoid inhaling this vapor. Once the pressure has equalized, the operator should loosen the plug further and remove it.

Pumping is the preferred drum-emptying method. Air pressure and gravity methods can cause excessive spillage. Use of a pump with flexible hose and a downpipe to the bottom of the drum is preferred. The pump, hose, and pipe should be constructed of the materials listed in the section on Storage Design (page 16).

When being emptied, drums should be in a well-ventilated location. Special caution should be taken when removing the downpipe, since the greatest potential for exposure occurs during downpipe removal. Respiratory equipment, an eye bath and a safety shower should be located in the area.

### *Disposal*

Drums used to store concentrated solutions of glutaraldehyde may be **(a)** resealed and offered for reconditioning, or **(b)** triple-rinsed (or equivalent) and offered for recycling, reconditioning, or puncture and disposal in a sanitary landfill, or other procedures approved by national or local authorities.

### *Drum Filling*

In drum-filling operations, the primary concern is adequate personnel protection. Operators should be wearing protective gloves, splashproof monogoggles, or both safety glasses with side shields and a wraparound full-face shield, and protective clothing. A drum lance or pipe that fills from the drum bottom should be used. Filling should be done in a well-ventilated area. Vapors should be drawn away from operating personnel. Respirators, safety showers, and eye baths should be located in the area.

All filling lines and equipment should be constructed of materials listed in the sections on Materials of Construction and Gasket Materials under Storage Design.

## *Tank Trucks*

### *Unloading*

Unload by pumping, air pressure, or gravity. Operators should first put on protective clothing, protective gloves, and splashproof monogoggles, or both safety glasses with side shields and a wrap-around full-face shield. Only then should the hatch be opened to vent the tank. It is not necessary to keep nitrogen over the truck; air displacement is adequate.

If unloading is done by pumping, a stainless steel centrifugal pump and stainless steel flexible hose are recommended for unloading. If pressure is used, air pressure is recommended. Connect the unloading valve and proceed to unload.

The storage vessel or drum being filled can be vented back to the truck or scrubber system if necessary to avoid odor and exposure to vapor.

### *Loading*

Trucks can be loaded from bulk storage tanks if appropriate piping configurations are available. Personnel should wear protective gloves, splashproof monogoggles, or both safety glasses with side shields and a wraparound full-face shield, and protective clothing. It is recommended that vapor be drawn away from operating personnel with a hood or fan during the loading operation.

## **Intermediate Bulk Containers**

Dow can fill customer-owned IBCs with glutaraldehyde-based solutions providing the following conditions are met:

- ◆ Tanks must be approved UN Intermediate Bulk Containers (IBCs). The manufacturer and model must be approved by Dow.
- ◆ Gaskets must be of Teflon,<sup>™</sup> Grafoil,<sup>™</sup> silicone, or Kalrez.<sup>™</sup>
- ◆ Tanks must be within retest limits for filling.

### ***In the United States:***

- ◆ Tanks, fittings, piping, valves, and accessories must be of stainless steel.
- ◆ Total dimensions must not exceed 48 inches (122 cm) in diameter and 62 inches (157 cm) in height.
- ◆ Gross weight must not exceed 10,000 lb (4540 kg).
- ◆ Tanks must be thoroughly cleaned, drained, and dried prior to shipment to Dow.

Further details on the Intermediate Bulk Container Program are available from your Dow Sales Representative or the Dow Customer Information Group.

## ***First Aid Information for all Glutaraldehyde Products***

### ***If Swallowed:***

- ◆ Call a poison control center or a doctor immediately for treatment advice.
- ◆ ***DO NOT INDUCE VOMITING.***
- ◆ Do not give anything to drink.

### ***If in Eyes:***

- ◆ Wash immediately and continuously with flowing water for at least 30 minutes.
- ◆ Remove contact lenses after the first 5 minutes and continue washing.
- ◆ Obtain prompt medical consultation, preferably from an ophthalmologist.

### ***If on Skin or Clothing:***

- ◆ Take off contaminated clothing.
- ◆ Rinse skin immediately with plenty of water for 15-20 minutes.
- ◆ Call a poison control center or a doctor for treatment advice.

### ***If Inhaled:***

- ◆ Move person to fresh air.
- ◆ If person is not breathing, call emergency services and then give artificial respiration, preferably mouth-to-mouth if possible.
- ◆ Call a poison control center or a doctor for further treatment advice.



# GLUTARALDEHYDE LABELING STATEMENTS – NORTH AMERICA

## *All Products Containing >5% Glutaraldehyde*

- ◆ **DANGER!** Corrosive. Causes irreversible eye damage.
- ◆ Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals.
- ◆ Causes asthmatic signs and symptoms in hyper-reactive individuals.
- ◆ Do not get in eyes, on skin, on clothing.
- ◆ Avoid breathing vapor.
- ◆ Do not swallow.
- ◆ Wear goggles, protective clothing and gloves.
- ◆ Wash thoroughly with soap and water after handling.
- ◆ Remove contaminated clothing and wash before reuse.
- ◆ Keep container closed.
- ◆ Use with adequate ventilation.

## **Additional Statements for:**

### *Products Containing >5% but <25% Glutaraldehyde*

- ◆ Causes skin irritation.
- ◆ Harmful if inhaled.
- ◆ Harmful if swallowed.

### *Products Containing 25% Glutaraldehyde*

- ◆ Causes skin irritation.
- ◆ Harmful if inhaled.
- ◆ Harmful if swallowed.
- ◆ Harmful if absorbed through skin.

### *Products Containing >25% but <45% Glutaraldehyde*

- ◆ Causes skin irritation.
- ◆ Harmful if inhaled.
- ◆ May be fatal if swallowed.
- ◆ Harmful if absorbed through skin.

### *Products Containing 45% to 50% Glutaraldehyde*

- ◆ Causes skin burns.
- ◆ Harmful if inhaled.
- ◆ May be fatal if swallowed.
- ◆ Harmful if absorbed through skin.



# EUROPEAN PRODUCT CLASSIFICATION INFORMATION

Products containing glutaraldehyde are classified as “dangerous” according to the European Dangerous Substance Directive (67/548/EEC), the Dangerous Preparations Directive (88/379/EEC), and their amendments. The applicable Danger Symbols, Risk phrases (R-phrases), and Safety Advice phrases (S-phrases) are listed below:

<i>Products Containing</i>				
<i>Equal to or greater than</i>	<i>Less than</i>	<i>Danger Symbol</i>	<i>R Phrases</i>	<i>S Phrases</i>
0.5%	1%	Xi	36/37/38, 43	24, 37
1%	2%	Xn	36/37/38, 42/43	23, 24/26, 37
2%	10%	Xn	20/22, 37/38, 41, 42/43	23, 24/26, 37/39
10%	25%	C	20/22, 34, 42/43	23, 26, 36/37/39, 45
25%	50%	T, N	22, 23, 34, 42/43, 50	23, 26, 36/37/39, 45, 61
50%		T, N	23/25, 34, 42/43, 50	23, 26, 36/37/39, 45, 61

## **Transport Classifications**

Products containing  $\geq 42.5\%$  glutaraldehyde are considered dangerous for transport and have the following classifications:

	<i>ADR/RID</i>		<i>IMDG</i>		<i>ICAO</i>	
	42.50%	50	42.50%	50	42	50
<b>Proper Shipping Name</b>	Corrosive Liquid, toxic, n.o.s. (contains glutaraldehyde)	Corrosive liquid, acidic, organic, n.o.s. (glutaraldehyde solution)	Corrosive Liquid, toxic, n.o.s. (contains glutaraldehyde)	Corrosive liquid, acidic, organic, n.o.s. (glutaraldehyde solution)	Corrosive Liquid, toxic, n.o.s. (contains glutaraldehyde)	Corrosive liquid, acidic, organic, n.o.s. (glutaraldehyde solution)
<b>Class</b>	8	8	8	8	8	8
<b>Label</b>	8,6.1	8	8,6.1	8	8,6.1	8
<b>Pack Group</b>	II	II	II	II	II	II
<b>UN Number</b>	2922	3265	2922	3265	2922	3265
<b>Kemmler Number</b>	86	80	—	—	—	—
<b>EmS Number</b>	—	—	F-A, S-B	F-A, S-B	—	—

## Storage Stability

Under proper conditions, aqueous glutaraldehyde solutions may be stored for extended periods of time without adverse effects. The rate of loss of activity will be determined principally by the following conditions of storage:

- ◆ Temperature
- ◆ pH
- ◆ Product contamination

The most important factor affecting the useful storage lifetime of glutaraldehyde solutions is temperature. The material should be stored at or below room temperature whenever possible in order to minimize decomposition. Glutaraldehyde solutions show no change in concentration after one year of storage at 25°C and 37°C. However, storage at elevated temperatures for extended periods will shorten the shelf life.

Freezing will normally have no impact on the activity of glutaraldehyde-based solutions. Even repeated cycles of freezing and thawing will not cause any significant degradation of the material. However, when glutaraldehyde solutions are frozen relatively slowly, as might occur in large containers or at temperatures only slightly below the freezing point, stratification may be observed. The resulting solution will be more concentrated at the bottom of the container than at the top. This effect is more pronounced with solutions containing lower concentrations of glutaraldehyde (15 percent), but does not seem to grow worse with repeated freeze-thaw cycles. When possible, freezing should be prevented. If freezing does occur, drums should be slowly thawed (avoiding localized hot spots) and mixed until homogeneous. Bulk storage tanks should likewise be thawed slowly and then recirculated to counteract stratification.

The pH of glutaraldehyde-based solutions will also have a major impact upon their useful lifetimes. The active material is most stable at a pH around 4.0 and is shipped in this condition. Concentrated solutions tend to become more acidic upon storage, particularly at elevated temperatures. This pH decrease will not have any significant effect on the stability of the solutions. Addition of alkaline materials to concentrated solutions should be avoided, since the lifetime of the material is decreased at an elevated pH.

Contamination of concentrated solutions of glutaraldehyde with substantial quantities of other materials may adversely affect product stability. In particular, high concentrations of ammonia, amines, or products containing these substances should be carefully avoided, since they will react readily with glutaraldehyde. As with all chemicals, storage containers of glutaraldehyde should be tightly closed and protected from other materials when not in use.

In addition, trace levels of iron will adversely impact the storage stability of glutaraldehyde. Therefore, all product transfers should avoid even transient contact with mild steel.

When kept under optimal conditions, glutaraldehyde-based solutions may be stored in sealed containers for over two years. Under more adverse conditions encountered in the field, storage lives of over one year are commonly observed. However, to minimize or prevent polymer buildup, we recommend a storage time of no longer than 6-12 months.

## Storage Design

Materials of construction, temperature control, and handling procedures are important considerations in maintaining high-quality glutaraldehyde products.

### Materials of Construction

Solutions of glutaraldehyde are in general equal to or slightly less corrosive than water at an equivalent pH. Since the pH of these solutions is relatively low (3.1 to 4.5), materials such as carbon steel, aluminum, iron, copper, and monel should not be used for bulk storage facilities. In addition to equipment damage from corrosion, these materials of construction will lead to product contamination.

Suitable materials of construction for tanks, pumps, and piping are listed below.

#### Recommended Materials of Construction

Stainless steel types 304 and 316

Nickel

Fiberglass-reinforced plastics:  
Polyester (e.g., "Atlac" 382)

Vinylester (e.g., "Derakane" 411 or 470)

High Density Polyethylene

Lined steel containers are not recommended for bulk storage, since pinhole leaks could cause product contamination. Rubber linings are also unsuitable because of the potential for swelling.

### Gasket Materials

Gasket materials should be chosen carefully, since the use of incompatible materials may lead to product leakage or material failure. Silicone, Teflon,<sup>™</sup> Kalrez,<sup>™</sup> or Grafoil<sup>™</sup> are recommended for all gaskets.

### Nitrogen Blanketing/Venting

Dow stores glutaraldehyde-based solutions in nitrogen-blanketed atmospheric tanks to maintain quality. Tanks are pressurized to 0.13–0.5 psi (6.4–26 mm Hg), depending on vent unit type. Storage under nitrogen is preferred but not mandatory; comparison of glutaraldehyde-based solutions stored under air and under nitrogen has not shown significant product quality differences. Dow recommends using a vapor-tight vent unit, instead of an open vent, to reduce odor and minimize emissions.

### Temperature

As outlined in the section on Storage Stability (see page 15), temperature control is the most important variable in maintaining high-quality solutions of glutaraldehyde. Bulk storage tanks should be insulated to prevent freezing or overheating. The recommended storage temperature range is between room temperature and the freezing point of the glutaraldehyde solution. Provisions should be made for heating bulk storage tanks in cold climates or for cooling in hot climates.

Freezing glutaraldehyde-based solutions may lead to product stratification and should, therefore, be avoided. If the product freezes, it should be thawed gradually in order to minimize hot spots. Heating should be carried out slowly with hot water coils or electrical tracing, and the element temperature should be less than 60°C. The thawed material should then be thoroughly mixed, in order to return the solution to homogeneity.

Storage of glutaraldehyde-based solutions at elevated temperatures may cause formation of polymers and concomitant loss of monomeric material. While storage at temperatures as high as 37°C may have little or no effect on product activity, color formation may be appreciable. Therefore, storage for extended periods at elevated temperatures is not recommended.

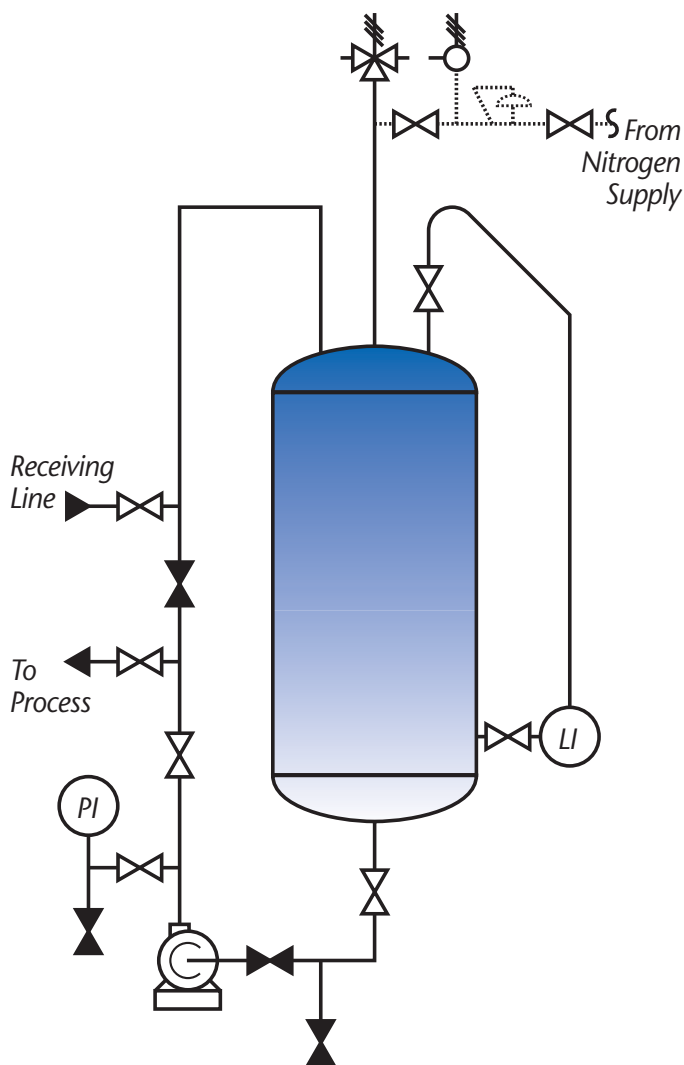
### pH

The recommended pH for storage of glutaraldehyde-based solutions is 3.1 to 4.5. Although the pH of the material may become more acidic over time, this normally will cause no decrease in storage stability. Solutions containing glutaraldehyde will polymerize under alkaline conditions and should not be stored in concentrated form above pH 4.5.

### Typical Bulk Storage System

Figure 1 illustrates Dow's typical storage tank for glutaraldehyde-based solutions. Dow prefers to store these solutions in insulated, stainless steel vessels that are tall in relation to their diameter. Round-bottomed tanks on legs with bottom draw-down are generally used. Stainless steel centrifugal pumps are used for transfer service.

**Figure 1 – Bulk Storage Tank for Glutaraldehyde-Based Solutions**



#### NOTES:

1. Insulate tank and lines if storage is outdoors. Provide electric or warm water 60°C (140°F) (max.) heating if extended ambient temperatures below solution freezing point are expected.
2. Nitrogen blanketing is preferred but not essential.

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## *Polymerization Prevention*

Additional design practices are available to minimize or prevent polymer buildup or plugging. A recirculation system will keep the contents of the tank well mixed during drawdown and prevent pump dead-heading. The piping system should be designed with the shortest possible storage line between the pump suction and the tank. Check valves should be avoided. Bulk storage tanks should be constructed so that the entire volume of the tank is consumed in normal operation every six to twelve months (depending on storage conditions). This will minimize storage time and will thus ensure that fresh material is available on a continual basis. Note that it is therefore undesirable to continually top off a single bulk storage tank. If this is done on a routine basis, it is likely that polymer buildup will occur (as aged glutaraldehyde collects at the bottom of the tank) and will worsen as the period between complete emptying of the tank lengthens. Ideally, dual bulk storage tanks would be employed so that one can be completely emptied before it is refilled and still maintain an adequate inventory of glutaraldehyde-based solutions.

## *Spill Control*

Bulk storage tanks should be diked to contain the full volume of the largest storage tank. The diked area should be provided with independent drains to the clean and process sewers. The sewers should be valved shut during normal operation. The clean sewer drain can be opened during rainstorms and the process drain can be valved open as needed. Alternatively, any spills can be removed by vacuum truck and trucked to a treatment plant.

Large spills that cause eye, nasal, and respiratory irritation indicate that the area should be evacuated and cleaned up by a trained team. The appropriate safety and governmental personnel should be notified immediately.

Avoid making contact with spilled material, taking care not to step in it since glutaraldehyde will be absorbed by most shoes. To clean up small spills, wear the appropriate protective equipment and cover the liquid with absorbent material. Collect and seal the material in polyethylene bags and place in a drum for transit to an approved disposal site.

Dirt that has absorbed the spilled material should also be collected and similarly disposed.

The remaining spilled material may be diluted with water to reduce odor, but only if this would not cause a large amount of glutaraldehyde to feed into a natural waterway. (See page 6 for additional spill clean up information.)

## *Equipment Cleanup*

Tanks can be cleaned with water. High-pressure water can be used if polymerization has occurred. This is a physical cleaning method. Glutaraldehyde polymer is not soluble in water. If water pressure does not adequately cleanse the tank, more aggressive physical or chemical cleaning methods may be required. Tank cleaning should be an infrequent requirement.

When considering the use of any glutaraldehyde product in a particular application, you should review the latest Material Safety Data Sheets and ensure that the use you intend can be accomplished safely. For Material Safety Data Sheets and other product safety information, contact the Dow Customer Information Office. Before handling any other products mentioned in the text, you should obtain available product safety information and take necessary steps to ensure safety of use.

No chemical should be used as or in a food, drug, medical device, or cosmetic, or in a product or process in which it may contact a food, drug, medical device, or cosmetic until the user has determined the suitability and legality of the use. Since government requirements and use conditions are subject to change, it is the user's responsibility to determine that this information is appropriate and suitable under current, applicable government requirements.

Dow requests that the customer read, understand, and comply with the information contained in this publication and the current Material Safety Data Sheet(s). The customer should furnish the information in this publication to its employees, contractors, and customers or any other users of the product(s), and request that they do the same.

Dow offers a broad line of trademarked glutaraldehyde-based solutions for use in microbiocidal applications. These products are registered with the U.S. Environmental Protection Agency and regulated by the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) in the United States, and by similar legislation in many other countries or international organizations. Be sure to understand and comply with any governmental requirements applicable to your use of glutaraldehyde.

For additional information on available products, specifications, and Material Safety Data Sheets, contact the Dow Customer Information Office.

# EMERGENCY SERVICE

For emergency service:

Mainland United States and Puerto Rico, call:  
1-989-636-4400.

For further information visit our website:  
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