

# TOXICITY OF A HYDROGEN PEROXIDE-BASED DECONTAMINATION SOLUTION (DECON GREEN) IN WATER AND SOIL EXTRACTS

Mark V. Haley\*, Carl W. Kurnas, and Ronald T. Checkai  
U. S. Army Edgewood Chemical and Biological Center,  
Aberdeen Proving Ground, MD 21010-5424 USA

Steven D. Turley, Michelle A. Osborn and Dennis T. Burton  
University of Maryland, Wye Research and Education Center  
Queenstown, MD 21658

## ABSTRACT

The U.S. Army has developed a hydrogen peroxide-based decontaminating solution, Decon Green (DG). The components of the decon solution are less hazardous to the end-user and the environment than standard decon solutions that are in the current inventory. Toxicity studies were conducted as direct amendments of DG into water, and into soil. Aquatic organisms were exposed directly to water amended with DG. Soils amended with DG were subjected to an Adapted Toxicity Characteristic Leaching Procedure (ATCLP) in order to produce exposure solutions. In addition, we performed corresponding toxicity investigations using DG solution that was allowed to age. Overall, *Vibrio fischeri* was less sensitive to DG than *D. magna* and *C. dubia* by approximately one order of magnitude. Provisional data indicate that the 5-min EC<sub>50</sub> for *Vibrio fischeri* was 200 ppm (vol/vol), and the 48-hr EC<sub>50</sub> for *D. magna* and *C. dubia* were 26 and 25 ppm (vol/vol), respectively; IC<sub>50</sub> for *C. dubia* exposed to DG directly amended into water was 28 ppm (vol/vol), while the IC<sub>50</sub> for *C. dubia* exposed to extracts of soils amended with GD was 2400 ppm (mass/mass; in soil). Based on acute aquatic toxicity, DG was substantially less toxic to these organisms than traditional decontamination solutions.

## 1. INTRODUCTION

The U.S. Army has developed a hydrogen peroxide-based decontaminating solution, Decon Green (DG), effective against chemical as well as biological agents (Wagner et al., 2002). The components of the hydrogen peroxide-based decon solution are less hazardous to the end-user than decon solutions currently in the inventory [Decontaminating Solution (DS-2), and Decontaminating Agent: Multipurpose (DAM)] (Haley et al., 1994a, Haley et al., 1994b). A component of DS-2 (ethylene glycol monomethyl ether, EGME) has been determined to cause birth defects, fetotoxicity and bone marrow complications in laboratory animals (Sigma Aldrich, 1989). Both DS-2 and DAM contain a component that is highly corrosive,

creating compatibility problems and additional hazards to the end user and the environment. Safety data sheets and open literature publication exist on the individual components of DG. However, environmental information on the mixture is lacking. Using the information provided on individual components can only provide speculation on environmental effects, and does not account for possible synergistic or antagonistic interactions. The studies described in this report will provide baseline toxicity screening levels on both neat, and aged DG solutions. This information can be used in the preparation of Environmental Assessments (EA), needed before new candidate materials can be fielded. This study does not address the possible change in toxicity due to the method of deployment or property changes resulting from agent neutralization.

The DG formulation consist of potassium molybdate, potassium carbonate, hydrogen peroxide, propylene carbonate, and Triton X-100<sup>®</sup>. Since a principal component of the DG mixture is hydrogen peroxide (30% by volume), it was assumed that the primary toxicity of DG would be reduced and possibly eliminated after relatively short exposure or contact with soil. Therefore toxicity studies were conducted as direct fresh amendments into water, and into soil. Aquatic organisms were exposed directly to the water amended with DG. Soils (Sassafras Sandy Loam) amended with DG were subjected to an Adapted Toxicity Characteristic Leaching Procedure (ATCLP) in order to produce exposure solutions. In addition, we performed corresponding toxicity investigations using DG solution that was allowed to age with intermittent stirring until visible bubbles from hydrogen peroxide activity had ceased.

Although a number of aquatic organisms are available for short term testing, we selected the marine luminescent bacteria *Vibrio fischeri*, and fresh water crustacean *Daphnia magna* for conducting short term (5 minute, and 48 hour respectively) acute toxicity assays. The fresh water crustacean *Ceriodaphnia dubia* was selected as the

# Report Documentation Page

*Form Approved*  
*OMB No. 0704-0188*

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

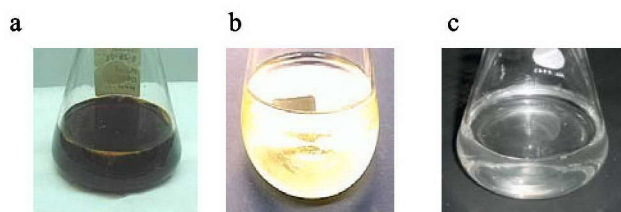
1. REPORT DATE <b>00 DEC 2004</b>	2. REPORT TYPE <b>N/A</b>	3. DATES COVERED -			
4. TITLE AND SUBTITLE <b>Toxicity Of A Hydrogen Peroxide-Based Decontamination Solution (Decon Green) In Water And Soil Extracts</b>		5a. CONTRACT NUMBER			
		5b. GRANT NUMBER			
		5c. PROGRAM ELEMENT NUMBER			
6. AUTHOR(S)		5d. PROJECT NUMBER			
		5e. TASK NUMBER			
		5f. WORK UNIT NUMBER			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>U. S. Army Edgewood Chemical and Biological Center, Aberdeen Proving Ground, MD 21010-5424 USA; University of Maryland, Wye Research and Education Center Queenstown, MD 21658</b>		8. PERFORMING ORGANIZATION REPORT NUMBER			
		10. SPONSOR/MONITOR'S ACRONYM(S)			
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		11. SPONSOR/MONITOR'S REPORT NUMBER(S)			
		12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>			
13. SUPPLEMENTARY NOTES <b>See also ADM001736, Proceedings for the Army Science Conference (24th) Held on 29 November - 2 December 2005 in Orlando, Florida. , The original document contains color images.</b>					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>UU</b>	18. NUMBER OF PAGES <b>2</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

primary test organism, used in determining the effects on reproduction after seven days of exposure.

## 2. RESULTS

Bubbles from the hydrogen peroxide off-gassing made transfer of fresh samples of DG difficult. Pipettes had to be rinsed several times with DG to reduce off-gassing in order to maintain desired volume for transfer. After aging 16-17 days, the DG solution had separated into two distinct layers. The top layer being clear, and the bottom layer pale clear-yellowish in color. After aging 30 days the solution was clear with no color, and layering that was difficult to distinguish (Figure 1).

Figure 1. Aged Decon Green after; a. 30 minutes, b. 7 days, and c. 30 days.



DG was approximately two orders of magnitude less toxic to *Vibrio fischeri* than DAM, and one order of magnitude less toxic than DS-2. Decon Green was two orders of magnitude less toxic to *D. magna* than DAM, and approximately 1.5 times less toxic than DS-2. Provisional data indicate that the 5-min  $EC_{50}$  for *Vibrio fischeri* was 200 ppm (vol/vol), and the 48-hr  $EC_{50}$  for *D. magna* and *C. dubia* were 26 and 25 ppm (vol/vol), respectively;  $IC_{50}$  for *C. dubia* exposed to DG directly amended into water was 28 ppm (vol/vol), while the  $IC_{50}$  for *C. dubia* exposed to extracts of soils amended with GD was 2400 ppm (mass/mass; in soil). After 16 days of aging, the DG solution the toxicity to *Vibrio fischeri* was reduced one order of magnitude. We are currently investigating reproductive effects on *C. dubia* using aged DG.

## 3. CONCLUSION

Based on acute aquatic toxicity, neat DG is less toxic to *Daphnia magna* and *Vibrio fischeri* than DS-2 and DAM decon solutions. Provisional results show the toxicity of DG to *Vibrio fischeri* decreases over time. Using the Chemical Scoring System for Hazard and Exposure Identification (O'Bryan et al., 1988), the overall aquatic toxicity score for DG was rated 5 (slightly toxic to aquatic organisms).

## REFERENCES

- Sigma Aldrich Corporation, 1989: Material Safety Data Sheet, 1001 West Saint Paul Ave., Milwaukee, WI 53233.
- O'Bryan, T.R. and Ross, R. H., 1988: Chemical Scoring System for Hazard and Exposure Identification, J. of Toxicology and Environmental Health, 1:119-134.
- Haley, M. V., Chester N., A., Kurnas, C. W., Muse, W. T., 1994a: Aquatic Toxicity of the Decontaminating Agent: Multipurpose (DAM) Decontamination Solution, Edgewood Chemical biological Center, Technical Report ERDEC-TR-149.
- Haley, M. V., Chester N., A., Kurnas, C. W., Phillips, C. T., 1994b: Aquatic Toxicity of Decontaminating Solutions DS-2/DS-2P, Edgewood Chemical biological Center, Technical Report ERDEC-TR-202.
- Wagner, G. W. and Yang, Y. C., 2002: Rapid Nucleophilic Oxidative Decontamination of Chemical Warfare Agents, Ind. Eng. Chem. Res., Vol. 41, No. 8, pp. 1925-1928.