

US EPA ARCHIVE DOCUMENT

AAUS 2010, Honolulu, HI – March 26

# Viking Dry Suit Decontamination Study

**Rob Pedersen<sup>1</sup>, Stephanie Harris<sup>2</sup>, Sean Sheldrake<sup>1</sup>,  
Stephanie Bailey<sup>2</sup>, and P. Bruce Duncan<sup>1</sup>**

U.S. EPA, Region 10 – 1 Dive Operations Team & EPA R10  
2 Laboratory Microbiology Team



*Serving Region 10 since 1968*

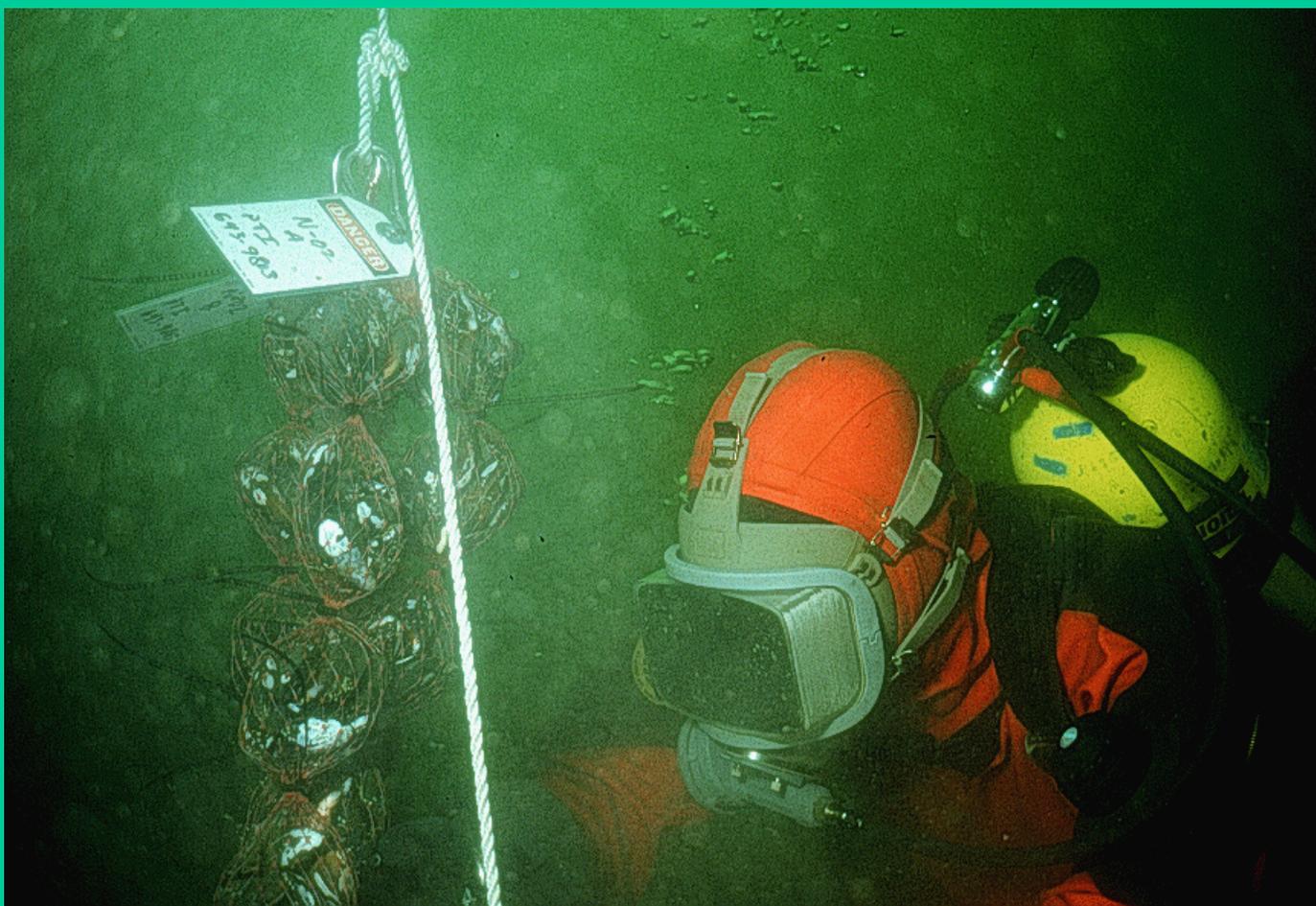
**ABSTRACT:** Government dive teams (public safety, military, resource, and regulatory branches), and commercial divers work in contaminated harbors and enclosed bodies of water prone to water column and sediment contamination. Decontamination polices and practices during dive operations in polluted water vary widely. Standard dress for EPA Region 10 divers is a Viking dry suit with hazmat valves, dry gloves, and a full-face mask. This laboratory study examined bacteriological decontamination effectiveness of *Pseudomonas*-contaminated Viking dry suit material after freshwater rinsing and after treatment with Betadine.



**Conclusion: A thorough freshwater rinse removes biological hazards from the Viking dry suit.**

McCormick & Baxter  
Portland Harbor, OR  
Decontamination Rinse

The EPA Region 10 dive team members work in polluted water conditions – contaminated water diving (CWD) from both biological and chemical hazards.

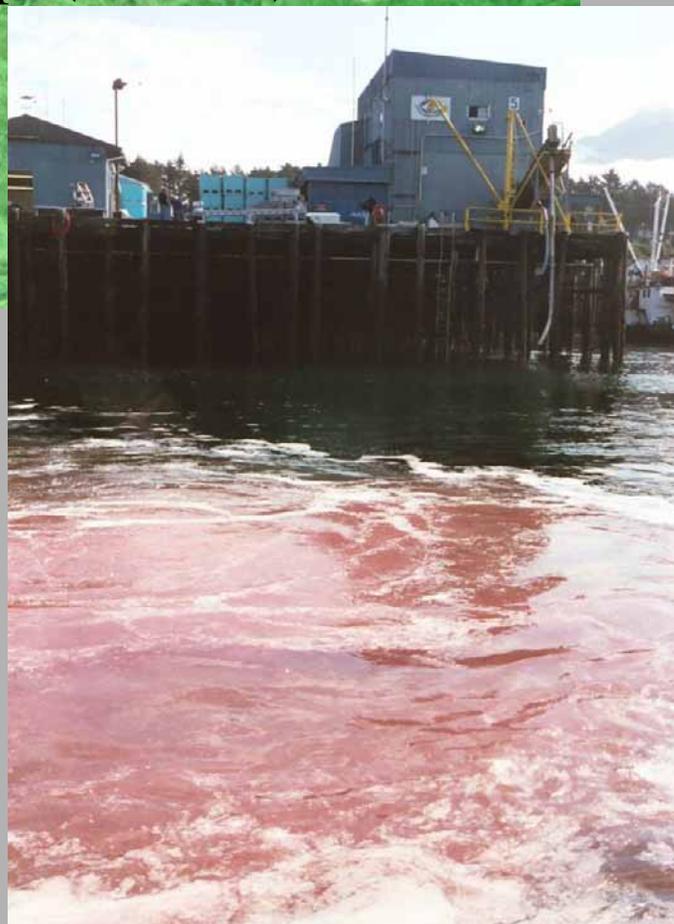


Examples are diving near wastewater treatment plant outfalls and storm water outfalls;



# seafood processor waste;

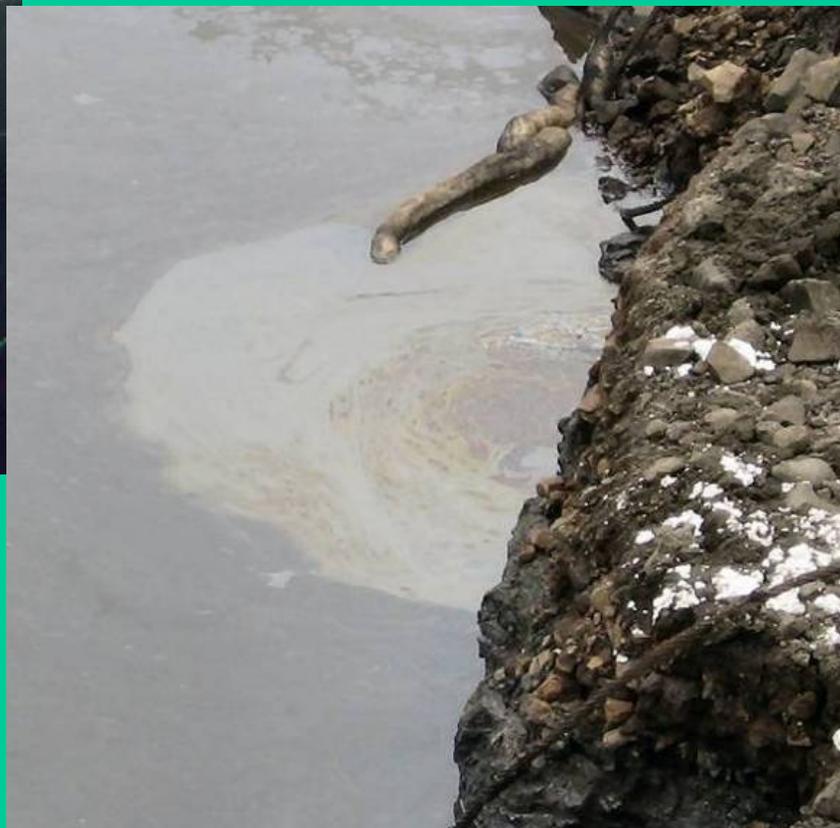
Old Waste Pile - Bones & Fins  
Seafood Producers Coop  
Five inches deep (7/30/03)



...and general chemical contaminants in the water column and sediment.



Sampling in a NPDES zone of deposit for a Superfund site groundwater treatment plan outfall.



Decontamination is intended not only to rid the diver of bottom sediments, but to dilute and rinse off microbial contamination.



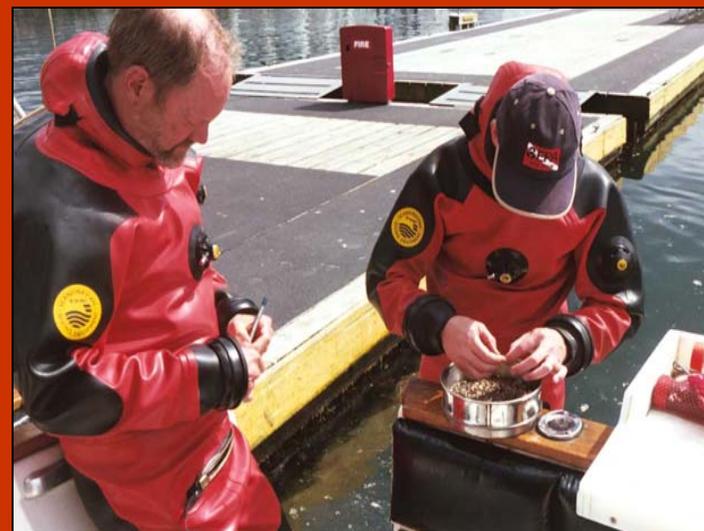
EPA Region 10 basic diver dress is typically an AGA (full face mask), dry gloves, and a Viking drysuit (vulcanized rubber for easier decontamination - Viking Pro EPDM/natural rubber (1000 gr/m<sup>2</sup>)).





- **Decon of divers** -- as they exit the water onto the vessel's swim step (exclusion zone).
- Our decon generally consists of a thorough potable water rinse.

- The literature -- for diver decontamination after exposure to water contaminated with pathogens, the initial diver rinse should be followed by spraying down the diver with a clinical disinfectant such as **Betadine** surgical scrub solution.
- The literature -- contact times of up to three minutes, or even ten minutes, are mentioned. It may also be necessary for the Betadine solution to dry after application.





What is necessary for microbial decon of our divers?

- Adequacy of **potable water rinse alone?**
- Is an application of **a disinfectant** needed?
  - What type?
  - For how long?

The objectives of the decontamination procedure study were to:

- 1) Determine the efficacy of the potable water rinse procedure for removal of bacteria on the Viking drysuit material.
- 2) Determine the efficacy of Betadine to kill bacteria present on the Viking drysuit material. Two different application periods (1 min. and 3 mins.)
- 3) The primary intent was to remove bacteria from the suit material; absent this, the intent was to kill bacteria *in-situ*.

- 6" x 6" squares of dry suit diving material were disinfected and allowed to air dry prior to use in this study.



- A standard aliquot of *Pseudomonas aeruginosa* containing approximately 10,000 cfu was applied to the swatches of pre-cleaned dive suit material. The level of bacteria in the standard aliquot was determined directly with each separate analytical run by testing in triplicate.

- The number of organisms recovered from the dive suit material after a 3 or 1 minute contact time on the dive suit material in the absence of the disinfectant was used as the bacterial load in the applied aliquot, or the “results per 100 ml.” This was also done in triplicate and results were averaged to obtain the level demonstrated in the report.



- Triplicate samples of dry suit material were used to determine the effectiveness of a 4.7 % solution of Betadine at reducing the number of bacteria present on the dive material within a timed exposure period. This was also done in triplicate for each set of data. Data table refers to log removal and percent removal.

***Results...***

## US EPA Region 10 Manchester Laboratory

### Microbiology Laboratory Record

#### Dry Suit disinfection Study using *Pseudomonas aeruginosa* (M.F.)

Sample Data							Presumptive		
			A	B	C	D	mPA (48 hr @ 41.5°)		
Lab number	Date of disinfection	Length of disinfection (minutes)	D2 results (initial spike)	Recovery from dry suit MF count (volume of rinsate mls)	Recovery from Dry suit (reported as spiked #)	Percent recovery from dry suit	Count (average of triplicate results)	Percent removal	Log removal
week 1a	7/15/2008	3	10,750	80 per 100	8000	74	3.7	99.95	3
week 1b	7/16/2008	3	10,250	119 per 100	11967	> 100	34.3	99.71	2
week 1c	7/18/2008	3	10,250	102 per 100	10200	99.7	9.3	99.99	4
week 2a	7/22/2008	1	16,750	157	15,733	94	1.3	99.99	4
week 2b	7/22/2008	1	16,750	157	15,733	94	0.3	99.99	4
week 2c	7/22/2008	1	16,750	157	15,733	94	2	99.98	3

## Results & the Objectives:

- 1) By comparison of column D2 (initial seeding) and column C in all sets of data:
  - A potable water rinse will effectively remove up to 100 % of the organisms [although there is a range of removal from 74 – 100 % (rsd 13.3 %)].
  - The data compiled from 3 sets of triplicate studies demonstrated a 99.98 % (rsd = 0.15 %) reduction of viable organisms using 4.7 % Betadine solution and a 3 minute exposure time.



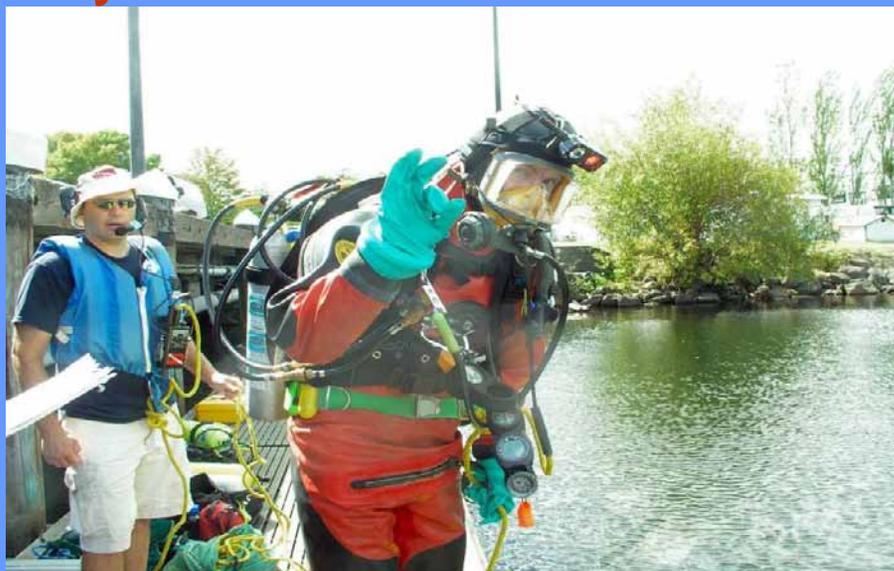
2) The data compiled from 3 sets of triplicate studies demonstrated a 99.99 % (rsd = 0.006 %) reduction of viable organisms using a 4.7 % Betadine solution and a 1 minute exposure time.

3) The organisms rinsed off the dive suit were viable and could present a biological hazard on board the vessel or in the waterway. Consideration should also be given to the fact that rinsewater from antimicrobial solutions should be collected and disposed of properly - e.g., to a publicly owned treatment facility.



This study has shown that it is unnecessary to spray the diver with Betadine and allow a period of time to pass before rinsing the diver again for dive sites with microbial contamination only.

Rapid decon reduces diver stress on hot days and improves overall efficiency of the operation. With our procedure, biological hazards that we carry out of the water are nearly all rinsed back into the water.





Serving Region  
10 since 1968\*

# How To Contact the EPA Dive Team and For More Information

- On the web

<http://yosemite.epa.gov/R10/OEA.NSF/webpage/Dive+Team>

- On the phone 1-800-424-4372

- Via email [pedersen.rob@epa.gov](mailto:pedersen.rob@epa.gov)

- Via snail mail

Rob Pedersen, USEPA, Mailstop  
OEA-095, Seattle WA 98101



## **Dry Suit Decon Study – Results table notes:**

**Notes: 1 ml of “C” dilution bottle should be 10,000 organisms and**

**D2 should be equivalent to 10 organisms/1 ml or 30 organisms per 3 ml. D = Calculate the percent recovery from the dry suit based on a 1 ml addition of dilution bottle “C”, this step will indicate the efficiency of removal and the concentration that should be used to determine the log “kill” of organisms on the test strip. Eg: see test above. 1 ml of “C” added to strips, calculated level of spike (8 (B)) x 10000 divided by expected (30) = 2667 actual seeded amount (A). Recovery of organisms off dry suit (C) = number counted on MF (B) X volume of rinsate, or using example (17 x 150 ml) = 2550 organisms in total spike.**

Percent recovery off dry suit by rinsing (D) = number of organisms recovered off dry suit(C)/calculated level of spike (A) x 100. (eg.  $2550/2667 \times 100 = 95.6 \%$ ).

Percent removal of organism from dry suit = Number of organisms recovered from dry suit before disinfection – number of organisms recovered after disinfection divided by number of organisms before x 100. Eg.  $(2667 - 0/2667) \times 100 = 100\%$ . Convert the percentage removed to log removal by conversion to log base 10. Based on significant figures, the log removal for this example would be 3.