STUDIES ON THE OCCURRENCE OF NDMA IN DRINKING WATER

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In November 1999, DHS began a study with several water systems that volunteered to participate to determine the occurrence of N-Nitrosodimethylamine (NDMA), especially as a disinfection byproduct. Nineteen water agencies, primarily in the San Francisco Bay and Los Angeles areas, participated.

NDMA was found to be a disinfection byproduct and to be present in the effluent at high levels from an ion exchange treatment facility. During disinfection, NDMA appears to be formed by several different reactions, depending on the water matrix and chemicals used.

This was confirmed by several water recycling agencies that have found NDMA in their plant effluents. In some instances, NDMA was found in groundwater wells that have been recharged with recycled water.

Analyses for several possible factors included chlorine residual (both free and total), pH, temperature, alkalinity, total organic carbon, nitrate-N, nitrite-N, ammonia-N, and total Kjeldahl nitrogen. No correlations could be found.

With the assistance of several water agencies that conducted some of their own studies, chloramination, cationic polymers, and detention times appear to be factors that may increase the levels of NDMA. Chloramination provides nitrogen species that may trigger the formation of NDMA. Some cationic polymers may be releasing precursors of NDMA into the water.

In some instances NDMA is formed slowly, so long detention times in the distribution system may increase the levels of NDMA. Nitrification by nitrifying bacteria may occur in systems that practice chloramination. Similarly, other bacteria species may cause the formation of NDMA. By controlling these factors, water systems should be able to reduce the levels of NDMA.

The NDMA results, in nanograms per liter, or parts per trillion (ppt), are presented for surface water treatment plants using chlorine, ozone, or chloramine disinfection (Table 1) and ion exchange treatment facilities (Table 2).

From these studies, DHS concludes that certain disinfection processes or ion exchange resins may lead to the formation of NDMA at levels greater than DHS' notification level (currently is 0.01 µg/L).

Table 1. NDMA Results from Surface Water Treatment Plants

Water System	Location	1st Round NDMA Results (ppt)	2nd Round NDMA results (ppt)	Disinfection
A	Plant Influent	<1		
A	Distribution	<1		Cl2
B	Plant Influent	<1	<1	
B	Plant Effluent	<1	<1	Cl2
B	Distribution	<1	<1	Cl2
C	Plant Influent	<1		
C	Plant Effluent	1.8	<1	O3/Cl2
C	Distribution	1.3	<1	O3/Cl2
D	Plant Influent	1.3	<1	

D	Plant Effluent	3.9	<1	O3/Cl2
D	Distribution	<1	<1	O3/Cl2
E	Plant Influent	<1	<1	
E	Plant Effluent	3.3	<1	Cl2
E	Distribution	<1	<1	Cl2
F	Plant Influent	1.1	<1	
F	Plant Effluent	1.5	<1	Cl2
F	Distribution	2.5	<1	Cl2
G	Plant Influent	<1		
G	Plant Effluent	<1		Chloramines
G	Distribution	<1		Chloramines
H	Plant Influent	1.8	<1	
H	Plant Effluent	<1	<1	Cl2
H	Distribution	1.4	<1	Cl2
I	Plant Influent	<1		
I	Plant Effluent	1	2	Chloramines
I	Distribution	4.3	1.6	Chloramines
J	Plant Influent	9.4	<1	
J	Plant Effluent	2.3	<1	Cl2
J	Distribution	1.4	<1	Cl2
K	Plant Influent	<1		
K	Plant Effluent	<1	1.1	Chloramines
K	Distribution	<1	1.8	Chloramines
L	Plant Influent	1.5	<1	
L	Plant Effluent	4.6	<1	Cl2
L	Distribution	4.4	<1	Chloramines
M	Plant Influent	<1		
M	Plant Effluent	<1		Chloramines
M	Distribution	<1		Chloramines
N	Plant Influent	1.2	1.1	
N	Plant Effluent	5.3	4.5	Chloramines
N	Distribution	7.4	3.8	Chloramines
O	Plant Influent	<1		
O	Plant Effluent	<1		
O	Distribution	3.2	<1	Chloramines
P	Plant Influent	2.4	<1	

P	Plant Effluent	3.2	1.8	Chloramines
P	Distribution	1.1	1.1	Chloramines
Q	Plant Influent	<1		
Q	Plant Effluent	<1		Chloramines
Q	Distribution	1.8		Chloramines
R	Plant Influent	1.1	1	
R	Plant Effluent	2.4	1.8	Chloramines
R	Distribution	1.8	1.5	Chloramines
S	Plant Effluent	<1		
S	Distribution	1.2		Cl2
T	Plant Influent	<1	3.9	
T	Plant Effluent	3	1.5	Chloramines
T	Distribution	3.7	1.3	Chloramines
U	Plant Influent	<1		
U	Plant Effluent	2.5	1.9	O3/Cl2
U	Distribution	6.8	2.6	O3/Cl2
V	Plant Influent	<1	<1	
V	Plant Effluent	1.7	1.8	Chloramines
V	Distribution	1.8	1.8	Chloramines
W	Plant Influent	<1		
W	Plant Effluent	<1		Chloramines
W	Distribution	1.7		Chloramines
X	Plant Influent	1.2	<1	
X	Plant Effluent	3.9	3.4	Chloramines
X	Distribution	4.4	4.6	Chloramines
Y	Plant Influent	<1		
Y	Plant Effluent	<1		Chloramines
Y	Distribution	<1		Chloramines
Z	Plant Influent	1.2	<1	
Z	Plant Effluent	1.1	<1	O3/Cl2
Z	Distribution	<1	<1	O3/Cl2
AA	Plant Influent	<1	1.7	
AA	Plant Effluent	63.7; 26.2; <1	2	Chloramines
AA	Distribution	2.4	2.2	Chloramines
BB	Plant Influent	<1		
BB	Plant Effluent	1.2		Chloramines

BB	Distribution	2.6	1.8	Chloramines
CC	Plant Influent	<1		
CC	Plant Effluent	2.4		Chloramines
CC	Distribution	28.3; 1.1		Chloramines
DD	Plant Influent	<1		
DD	Plant Effluent	<1		Chloramines
DD	Distribution	<1	1.1	Chloramines
EE	Plant Influent	<1		
EE	Plant Effluent	10.4; <1	<1	O3/Cl2
EE	Distribution	<1	<1	O3/Cl2
FF	Plant Effluent	18.3	2	Chloramines
FF	Distribution	15.8	13.4	Chloramines

Table 2. NDMA Results from Ion Exchange Treatment Facilities

Water System	Location	1st Round NDMA results (ppt)	2nd Round NDMA results (ppt)
GG	Plant Influent	4.5	<1
GG	Plant Effluent	34	30
GG	Distribution	28	21
HH	Plant Influent	6	
HH	Plant Effluent	3	
HH	Distribution	7	
II	Plant Influent		<1
II	Plant Effluent		1.2
II	Distribution		1.6
JJ	Plant Influent		<1
JJ	Plant Effluent		<1
JJ	Distribution		3.6