

**SECTION G: ENVIRONMENTAL ASSESSMENT****1. Date:**

September 15, 1995

2. Name of Applicant/Petitioner:

Lonza Inc.

3. Address:

17-17 Route 208
Fair Lawn, NJ 07410

4. Description of Proposed Action:

The petition requests FDA amend 21 CFR §176.170(a)(5) and §176.180(a)(2) by allowing for the use of hydroxymethyl-5,5 dimethylhydantoin (HMDMH) and 1,3-bis(hydroxymethyl)-5,5-dimethylhydantoin (BHMDMH) or "subject additives" as preservatives for clay-type fillers used in the manufacture of paper and paperboard. HMDMH and BHMDMH will be marketed under the trade name Dantogard™. The typical use level of HMDMH and BHMDMH (combined), in clay-type fillers, is 600 ppm, with a maximum level of 1200 ppm. HMDMH and BHMDMH will be produced at the petitioner's manufacturing site identified below:

Lonza, Inc.
3500 Trenton Avenue
Williamsburg, PA

Dantogard™ is 7.5% HMDMH and 32% BHMDMH; the remainder is water.

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Only negligible environmental releases are anticipated from the production of the subject additives since manufacture takes place in a closed system.

HMDMH and BHMDMH will be used by suppliers of clay-type fillers to prevent microbial contamination of filler materials during shipment and storage.

During the manufacture of paper, the subject additives may be released to process water and subsequently discharged with plant effluent. Based on the estimated environmental concentrations (EECs) and aquatic toxicity of the subject additives and degradates, as presented in Sections 7 and 8 of the *EA*, the petitioner does not anticipate any adverse effects on aquatic organisms.

Food packaging materials containing the subject additives will be used in patterns corresponding to national population density and will be widely distributed across the United States. Therefore, it is anticipated that disposal will occur nationwide, with about 80% of food packaging materials ultimately being deposited in land disposal sites, or to some extent recycled, and with about 20% being incinerated. Environments potentially affected by disposal are watersheds or groundwater receiving leachate from land disposal sites and areas subject to air emissions from landfills and incineration sites.

5. Identification of Chemical Substances that are Subject to the Proposed Action

Chemical Names: 2,4-Imidazolidinedione, (hydroxymethyl)-5,5-dimethyl
2,4-Imidazolidinedione, 1,3-bis(hydroxymethyl)-5,5-dimethyl

Common Names: Hydroxymethyl-5,5-dimethylhydantoin (HMDMH)
1,3-bis (hydroxymethyl)-5,5-dimethylhydantoin (BHMDMH)

CAS Reg. Nos. 27636-82-4 (HMDMH)
6440-58-0 (BHMDMH)

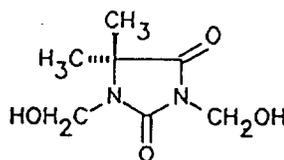
Molecular Weights: 158.16 (HMDMH)
188.10 (BHMDMH)

Chemical Formulas: $C_6H_{10}N_2O_3$ (HMDMH)
 $C_7H_{12}N_2O_3$ (BHMDMH)

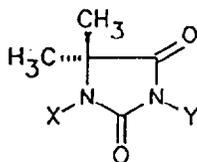
Impurity Associated with Subject Additives: Formaldehyde (2% maximum)

Structures:

1,3-Bis(hydroxymethyl) -5,5-dimethylhydantoin



Hydroxymethyl -5,5-dimethylhydantoin



X,Y = H or CH₂OH

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Chemical/Physical Properties (Dantogard)

Color: Water-white

Physical State: Liquid

Solubility:

<u>Solvent</u>	<u>Solubility (20°C)</u>
Methanol	Miscible, all proportions
Hexane	Insoluble
Toluene	Insoluble
Methylene Chloride	Insoluble
Ethylene glycol	Miscible, all proportions

- Viscosity: 3.2 centistokes
- pH: 6.5-7.5 (25°C)
- Hydrolysis: Upon hydrolysis, the subject additives form formaldehyde and dimethylhydantoin.

6. Introduction of Substances Into the Environment

a) Production Releases

HMDMH and BHMDMH are manufactured by reacting formaldehyde solution (~37%) and 5,5-dimethylhydantoin (DMH). Environmental releases of formaldehyde and DMH are insignificant since all unreacted materials are recycled back into production equipment. For example, formaldehyde is trapped by a scrubber and reused. No environmental releases of HMDMH and BHMDMH are expected during production.

b) Compliance with Emission Requirements

- Air Permit:

Air emissions from the production facility must comply with the following permit:

Air Quality Permit #41-313-011

- Water Permit:

There are no water emission requirements or permits applicable to the production of the subject additives.

c) Occupational Regulations

Occupational monitoring is done for the following OSHA regulated substance:

<u>Substance</u>	<u>Permissible Exposure Level</u>
Formaldehyde	0.75 ppm

d) Compliance Status

Approval of the subject additives, for the petitioned use, will not affect compliance with applicable emission and/or occupational exposure limits since the petitioner's manufacturing facility currently produces substantial quantities (several million lbs./year) of the subject additives for use in pesticide products and cosmetics and the facility is in full compliance with all regulations that govern the production of the subject additives.

e) Releases During Use

As indicated above, the subject additives are proposed for use as preservatives in clay-type fillers that are used in the manufacture of paper. The petitioner expects that almost all of subject additives will be retained by clay-type fillers during shipment and storage of the fillers. Environmental releases of the subject additives into water from the manufacture of paper¹ made with clay-type fillers can be estimated as follows:

Input Data

- **600 tons of food packaging paper/paper board is manufactured, per plant, per day².**
- **Total effluent at a paper mill is approximately 2 million gallons per day³.**
- **The maximum use rate of the subject additives is 1200 ppm or 0.0012 lbs/per lb. of clay filler.**
- **Approximately 10% of the weight of paper or paperboard is clay filler.**

¹According to USEPA's proposed effluent limitations rule for pulp and paper production (58FR, December 17, 1993, pg. 66101), the vast majority of water discharge is direct (91%). The rest is either indirectly discharged or disposed of by on-site land application.

²From a survey of a paper manufacturing facility.

³This effluent value is based on the following USEPA report: "Development Document for Effluent Limitations, Guidelines and Standards for Pulp, Paper and Paperboard" (1982). A recent survey by the National Council for Air and Stream Improvement (NCASI), shows the overall final effluent level to be much higher. Refer to Figure 5 in the article beginning on page 22 of the EA.

Calculations:

1. The Amount of the Subject Additives Released During Paper Manufacture

(Amount of Subject Additives Used per lb. of Clay-Type Filler) x (Weight percent of paper that is Clay-Type Filler) x (lbs/ton) x (Tons of Paper Produced per Day) =
Total Quantity of Subject Additives Released During Manufacture of Paper

$$(0.0012) \times (10\%) \times (2000 \text{ lbs./ton}) \times (600 \text{ tons/day}) = 144 \text{ lbs./day}$$

2. The Concentration of the Subject Additives in Plant Effluent

Amount of Subject Additives in Plant Effluent
Quantity of Plant Effluent

$$\frac{144 \text{ lbs./day}}{2 \times 10^6 \text{ gal/day}} \\ = 8.6 \text{ ppm}$$

Since MHDMH and BHMDMH rapidly hydrolyze, upon aqueous dilution, to DMH and formaldehyde, very low, if any, amounts of MHDMH and BHMDMH are expected in plant effluent. Since the maximum amount of formaldehyde that can be formed is 30% of the applied amount of MHDMH and BHMDMH the maximum formaldehyde concentration in plant effluent is 8.6 ppm x 0.30 or 2.6 ppm. Similarly, the concentration of DMH in plant effluent is 8.6 ppm x 0.70 or 6 ppm.

The above estimates are "worst-case" values. The petitioner believes that the actual concentrations of DMH and formaldehyde in aqueous bodies receiving effluent from paper

manufacturing facilities will be substantially lower since:

- Significant dilution of plant effluent from paper manufacturing facilities by receiving bodies of water is expected¹.
- As discussed in Section 7 of the *EA*, formaldehyde will rapidly biodegrade and DMH, under acclimating conditions, will also biodegrade.

Modifying the estimates on page 7 by taking into account the dilution of plant effluent and biodegradation of formaldehyde and DMH provides aqueous concentrations of formaldehyde and DMH of approximately 130 ppb and 420 ppb, respectively².

e) Releases During Disposal

As noted above in Section 4, food packaging materials containing the subject additives are expected to be landfilled (80%) or incinerated (20%).

Based on the properties of the subject additives, the predominant species in paper packaging are DMH and formaldehyde. Assuming a maximum use rate of the subject additives, complete retention in paper and no loss during use, the maximum amount of DMH and formaldehyde in disposed paper packaging are 85 ppm and 35 ppm, respectively.

¹Based on a telephone conversation between Eliot Harrison (preparer of *EA*) and David Jones, Ecological Effects Branch, Office of Pesticide Programs, USEPA, July, 1995.

²Assuming 90% biodegradation and a dilution factor of 50%. The biodegradation factor assumes that the microbial population will be acclimated to DMH. The dilution factor is a rough estimate provided to Mr. Harrison by Mr. Jones.

Formaldehyde migrating from disposed paper packaging should be rapidly degraded by soil microorganisms. Under acclimating conditions, which are expected at disposal sites, DMH should also be biodegraded. In circumstances where DMH is not degraded, the soil leaching studies indicate that DMH will quickly disperse through soil. However, the soil concentration is anticipated to be insignificant due to the low residue levels of DMH in paper.

f) Product Label

Since the proposed use for the subject additives is pesticidal, registration¹ by the U.S. Environmental Protection Agency (USEPA) is necessary. USEPA registration requires that the petitioner use the label presented on page 10 when marketing the subject additives for any pesticidal use. Accordingly, the USEPA label will be used for the petitioned use.

¹Since the USEPA registers products, not particular ingredients, USEPA approval will be for Dantogard.

LONZA

17-17 ROUTE 208
FAIR LAWN, NEW JERSEY 07410 USA
EMERGENCY TEL. NO. 309-697-5400

DANTOGARD™ PRESERVATIVES

PRESERVING YOUR CONFIDENCE

PRECAUTIONARY STATEMENTS HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION

Harmful if swallowed, inhaled, or absorbed through the skin. Avoid breathing vapors or spray mist. Avoid contact with skin, eyes or clothing. In case of contact, immediately flush eyes or skin with plenty of water. Get medical attention if irritation persists.

ENVIRONMENTAL HAZARDS

Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance, contact your State Water Board or Regional Office of the EPA.

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

Pesticide Disposal: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

Container Disposal: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or if allowed by state and local authorities, by burning. If burned, stay out of smoke.

Contents: LIQUID

Active Ingredients

1,3-Bis(hydroxymethyl)-5,5-dimethylhydantoin	32.0%
Hydroxymethyl-4,4-dimethylhydantoin	7.5%
Inert Ingredients	60.5%

EPA Reg. #6836-119 EPA Est. #6836-PA-1
NET WEIGHT (as marked on container)

KEEP OUT OF REACH OF CHILDREN

CAUTION

STATEMENT OF PRACTICAL TREATMENT

EYES: Flush eyes with plenty of running water for several minutes. Seek medical attention if irritation develops or persists.
SKIN: Wash affected areas with plenty of water, and soap if available, for several minutes. Remove and clean contaminated clothing and shoes. Seek medical attention if irritation develops or persists.

INHALATION: Remove from area to fresh air. If not breathing, clear airway and start mouth-to-mouth artificial respiration or use a bag-mask respirator. Get immediate medical attention. If victim is having trouble breathing, transport to medical care and, if available, give supplemental oxygen.

INGESTION: If swallowed, give 3-4 glasses of water. Induce vomiting by placing a finger on the back of the victim's tongue. Give fluids until vomitus is clear. DO NOT induce vomiting or give anything by mouth to an unconscious or convulsing person. Seek medical attention.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

DANTOGARD™ preserves and controls the growth of bacteria in aqueous dispersions of inorganic minerals (clay-slurries) used in the manufacture of paper and paperboard. Use DANTOGARD™ at levels of 1.0 to 6.0 lbs. per ton (500-3000 ppm or 200-1200 ppm on an active ingredient basis) of aqueous mineral slurry.

7. Fate of Emitted Substances in the Environment

As noted above, the substances entering the environment from the use of the subject additives are formaldehyde and DMH.

Formaldehyde is not persistent in the environment. In water, formaldehyde usually undergoes rapid biodegradation - in a die-away test using water from a stagnant lake, degradation was complete in 30 hours under aerobic conditions and 48 hours under anaerobic conditions. Formaldehyde is also degraded by activated sludge and sewage in 48-72 hours.

Formaldehyde released into the atmosphere will both photolyze and react rapidly with free radicals, primarily hydroxy radicals. The measured half-life for photolysis in simulated sunlight is six hours. The half-life for reaction with hydroxy radicals is approximately 19 hours in clean air and about one-half that long in polluted air¹.

Several laboratory environmental fate studies have been performed with DMH. These studies show that DMH is hydrolytically and photolytically stable, mobile in soil, resistant to aquatic degradation under non-acclimating conditions, but ultimately biodegradable under acclimating conditions. The DMH studies are summarized in Table 1 on page 12.

¹Hazardous Substances Data Base (1993)

TABLE 1
Laboratory Environmental Fate Studies with DMH

Test	Test Description	Result
Hydrolysis	Hydrolysis of DMH was determined at pH 5, 7, and 9.	DMH is hydrolytically stable at all pH's.
Aqueous Photolysis	Photodegradation of DMH was evaluated by exposing DMH to a light source simulating natural sunlight for 30 days.	DMH is photolytically stable.
Aerobic Aquatic Metabolism	Microbial degradation of DMH was evaluated under non-acclimating aerobic conditions.	Minimal degradation of DMH was observed; half-life for degradation, under the conditions of this study, is 1170 days.
Anaerobic Aquatic Metabolism	Microbial degradation of DMH was evaluated under non-acclimating anaerobic (flooded sediment) conditions.	Minimal degradation of DMH was observed; under the conditions of this study, the half-life is 1144 days.
Soil/Sediment Adsorption/Desorption	Leaching potential of DMH was evaluated in several representative (clay loam, sandy loam and sand) soils.	DMH is highly mobile in all soil types.
Modified OECD Screening Test	DMH was exposed to a mixed microbial population (garden soil, secondary effluent and surface water) under minimal acclimating conditions.	By day 28, average percent removal of DMH was 10.1% indicating low level of biodegradation.
Modified SCAS Test Method	DMH was exposed to an enriched microbial population (secondary activated sludge and raw sewage) and acclimated for a 16-day period.	After an 16-day acclimation period, biodegradation of DMH proceeded rapidly. From test day 18 until study completion, average percent removals were greater than 95%. Consequently, under the conditions of the study, DMH is considered ultimately biodegradable.

8. Environmental Effects of Released Substances

• Subject Additives and DMH

The petitioner sponsored three acute aquatic toxicity studies with Dantoin DMDMH, which contains the same ingredients but is more concentrated than Dantogard™. The test organisms were two freshwater fish (bluegill sunfish and rainbow trout) and an aquatic invertebrate - *daphnia magna*. The test design was a 4-day static bioassay. The results of the studies are summarized in Table 2 below and complete test reports are in Appendix E of this petition.

The petitioner also sponsored two chronic aquatic studies (pages 896 and 926 of this petition) with DMH. These studies are summarized in Table 3.

The petitioner is also aware of several acute freshwater and marine studies performed with DMH that were sponsored by Great Lakes Chemical Company. It is the petitioner's understanding that these studies were submitted to FDA in support of Food Additive Petition (FAP) #4B4418. The results of the Great Lakes studies are summarized in Table 4.

The aquatic studies show that the subject additives are slightly toxic to aquatic organisms and that DMH, on an acute basis, is practically non-toxic to freshwater and marine animals and slightly toxic on a chronic basis.

TABLE 2Acute Aquatic Toxicity Studies Conducted with Dantoin DMDMH

Study	96-hr. LC ₅₀
Acute LC ₅₀ - Rainbow Trout	515 ppm
Acute LC ₅₀ - Bluegill Sunfish	173 ppm
Acute LC ₅₀ - <i>Daphnia magna</i>	37 ppm

TABLE 3Long-Term Aquatic Toxicity Studies Conducted with DMH

Study	NOEC ¹	MATC ²	LOEC ³
Life-Cycle Toxicity Test in <i>D. magna</i>	70.9 ppm	90 ppm	116 ppm
Early Life-Cycle Toxicity Test in the Fathead Minnow	14 ppm	20 ppm	29 ppm

¹No-Observable Effect Concentration²Maximum Allowable Toxicant Concentration³Lowest-Observable Effect Concentration

TABLE 4

Acute Aquatic Toxicity Studies¹ Conducted with DMH:
Studies Sponsored by Great Lakes Chemical Company

Study	Result
Acute LC ₅₀ - Rainbow Trout	96 hr. LC ₅₀ : > 972.2 mg DMH/L
Acute LC ₅₀ - Bluegill sunfish	96 hr. LC ₅₀ : > 1017 mg DMH/L
Acute LC ₅₀ - Fathead minnow	96-hr LC ₅₀ : > 1085 mg DMH/L
Acute LC ₅₀ <i>Daphnia magna</i>	48-hr. EC ₅₀ : > 1070 mg DMH/L
Acute LC ₅₀ Mysid shrimp	96-hr. LC ₅₀ : > 921.7 mg DMH/L
Acute LC ₅₀ - Sheepshead minnow	96-hr. LC ₅₀ : > 1006 mg DMH/L
Acute LC ₅₀ - Eastern Oyster	96-hr. EC ₅₀ : > 125 mg DMH/L

Formaldehyde:

According to the published literature, formaldehyde is slightly toxic to fish. The 96-hr. LC₅₀'s in the rainbow trout and fathead minnow are 440 ppm² and 38 ppm³, respectively.

Based on the above results, the toxic criterion concentrations (TCC's), as defined by 21 CFR §25.15(b)(6), for the subject additives, formaldehyde and DMH are given below:

- Subject Additives: 370 ppb⁴ (calculated as 1/100 of LC₅₀ value in *Daphnia*)
- Formaldehyde: 380 ppb (calculated as 1/100 of LC₅₀ value in fathead minnow)
- DMH: 20 ppm (lowest concentration causing any adverse effect)

¹All studies were static bioassays.

²Hazardous Substances Data Base (1993).

³Material Safety Data Sheet for Formaldehyde (Dupont).

⁴In all likelihood, the TCC for the subject additives merely reflects the aquatic toxicity of formaldehyde.

Aquatic Assessment:

The worst-case exposure value (aqueous concentration) for formaldehyde is slightly higher than the TCC for formaldehyde. However, as noted in Section 7, the petitioner expects formaldehyde to be rapidly degraded in the environment so that the actual exposure level should be significantly below the TCC.

Regarding DMH, the TCC for this substance is greater than the worst-case exposure value. Accordingly, the petitioner does not anticipate any adverse effects on aquatic organisms to result from DMH in plant effluent. In addition, the very high acute LC₅₀ values (~1000 ppm) reported by Great Lakes for DMH should obviate any concern for DMH.

9. Use of Resources and Energy

The subject additives are an alternative to additives currently approved under 21 C.F.R. 176.170 and 176.180 for use as clay-type filler preservatives: Kathon™ (5-chloro-2-methyl-4-isothiazoline-3-one and 2-methyl-4-isothiazoline-3-one) and Proxel™ GLX (1,2-benzisothiazoline-3-one).

Since the subject additives will replace currently used additives no net increase in resource and energy utilization should occur since the energy and resources required for manufacture of the subject additives will be offset by a decrease in the energy and resources required for existing additives.

In addition, since the intent of the subject additives is to prevent microbial contamination of clay-fillers used in manufacturing paper the proposed use will not materially change the use of paper packaging containing the subject additives.

Finally, the production, proposed use and disposal of the subject additives or degradates are not anticipated to affect threatened or endangered species or historic structures.

10. **Mitigation Measures**

No adverse environmental effects are anticipated if this petition is approved. Therefore, no mitigation measures are required.

11. Alternatives to Proposed Action

Since no potential adverse environmental effects are expected to occur, no alternative actions are necessary.

12. List of Preparers

This *Environmental Assessment* was prepared for Lonza Inc. by Eliot I. Harrison of Delta Analytical Corporation. Mr. Harrison's educational training is in biology and chemistry. He has over ten years experience in preparing regulatory submissions to government agencies.

Assisting Mr. Harrison in the preparation of the *Environmental Assessment* were Stanley Elman and Dr. Steven Carter of Lonza. Mr. Elman oversaw testing and development of the subject additives for the proposed use. Dr. Carter is a supervisory analytical chemist with Lonza's research group.

13. Certification

The undersigned official certifies that the information presented is true, accurate and complete to the best knowledge of Lonza Inc.

Name: Eliot I. Harrison

Title: Agent for Lonza, Inc.

Signature: 

Date: September 15, 1995

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Water Pollution

Progress in reducing water use and wastewater loads in the U.S. paper industry

Reid Miner and Jay Unwin

An NCASI survey shows that the U.S. paper industry has significantly reduced water use and wastewater loads since 1975.

An important and ongoing part of the National Council for Air and Stream Improvement's (NCASI) investigative program involves the periodic collection and organization of information characterizing wastes and emissions from the U.S. paper industry. This information not only strengthens the understanding of the capabilities of current waste and emission management practices, it also finds use in documenting the progress the industry has made in (a) making more efficient use of one of its most important raw materials, water, and (b) reducing its discharges. In an era of increasing public skepticism about the effectiveness of industry's efforts to protect and enhance the quality of the environment, such documentation takes on added importance.

This paper contains a summary of information obtained in a 1989 survey of NCASI's membership, which represents approximately 90% of U.S. production of pulp and paper. It documents the industry's progress in reducing water use, raw waste loads, and final effluent loads. In addition, the industry's sludge generation rates and increased reliance on beneficial uses for wastewater treatment sludges are documented.

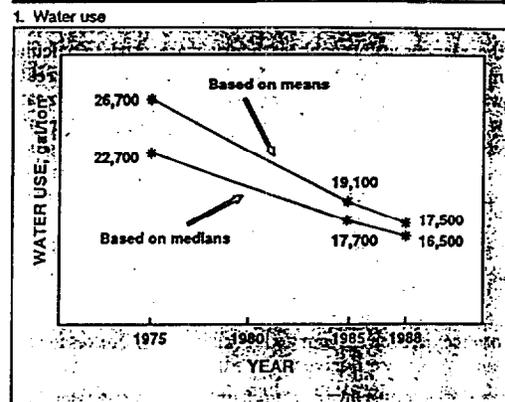
General approach

In the summer of 1989, NCASI distributed to its membership a survey requesting information on the industry's 1988 solid waste and wastewater management practices. The responses returned to NCASI represented approximately two-thirds of the industry's 1988 production.

In the survey, NCASI requested information on (among other things) water usage, untreated and treated wastewater flow, BOD and total suspended solids (TSS) loads, and sludge generation rates for the years 1975, 1985, and 1988. The information was provided on a per-unit-of-production basis.

The responses were divided into eight different

Miner is a program director and Unwin is a regional manager at NCASI, 260 Madison Ave., New York, N.Y. 10016.

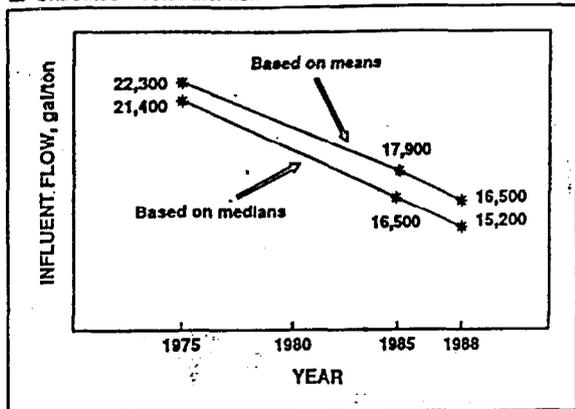


categories based on the principal production practices at each mill. These categories were:

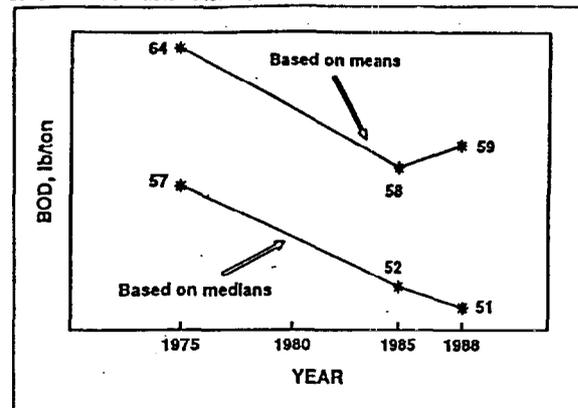
1. Nonintegrated paper and board mills
2. Mills producing paper and board from non-deinked wastepaper
3. Mills producing paper and board from deinked wastepaper
4. Mills producing paper and board from mechanical (or related) pulps
5. Sulfite mills
6. Semichemical mills
7. Unbleached kraft and kraft cross-recovery mills
8. Bleached kraft and soda mills.

Only eight categories were used to ensure that there were an adequate number of mills in each category. However, while this categorization scheme is adequate for estimating overall industry statistics, it disguises some important mill-to-mill differences in waste characteristics related to differences in the types of raw materials, processes, and waste treatment methods being used, and in the products being manufactured. We caution the

2. Untreated wastewater flow



3. Untreated wastewater BOD



reader not to use this categorization scheme for any purposes where such differences might be important.

After checking the data for obviously erroneous entries, the responses for each category were used to calculate median and mean values for 1988 water use, untreated wastewater flow, untreated wastewater BOD, untreated wastewater TSS, treated wastewater flow, treated wastewater BOD, treated wastewater TSS, and sludge generation. Also calculated for each category were median and mean percent reductions (or increases) in these values during the periods 1985-1988 and 1975-1988.

Overall industry figures per unit of 1988 production were derived by calculating weighted average water use and waste generation values over the industry, the weighting being based on the relative production of final product in each category. Overall industry figures for 1985 and 1975 were derived by reducing the 1988 water use or waste generation values for each category by the amounts indicated by the survey responses, and using these revised figures to calculate 1985 and 1975 weighted averages.

In the following sections, we report overall industry figures calculated two ways; the first is based on mean values for water use, waste generation, and percent reduction for each category, and the second is based on the corresponding median values.

Water use by the U.S. paper industry

The overall industry water use per ton of production in 1988, 1985, and 1975 are shown in Fig. 1.

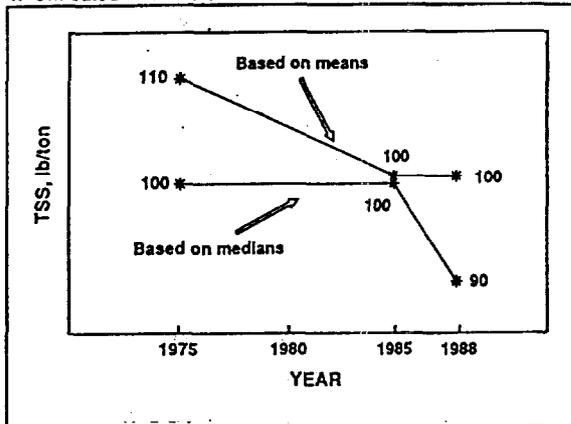
The data in this figure indicate a reduction in water use from 1985 to 1988 of 7-8%, and a reduction from 1975 to 1988 of 27-34%. In 1988, it took approximately 16,000-17,000 gal of water to produce a ton of paper or board in the United States. Data presented later in this paper indicate that this is 70% less than was required to make a ton of paper in 1959.

Wastewater flow to treatment

Overall industry figures for the wastewater flow to treatment in 1988, 1985, and 1975 are shown in Fig. 2.

Not unexpectedly, these data indicate reductions in

4. Untreated wastewater TSS



wastewater flow to treatment of approximately the same magnitude as documented for water use in Fig. 1. Between 1985 and 1988, untreated wastewater flows were reduced by approximately 8%, while the reductions accomplished between 1975 and 1988 were 26-29%.

Wastewater BOD to treatment

The amounts of BOD contained in the industry's wastewater before treatment are shown in Fig. 3.

These data suggest relatively little change in wastewater BOD going to treatment between 1985 and 1988 (the values for the two years are within approximately 2% of each other), and a reduction from 1975 to 1988 of 8-11%.

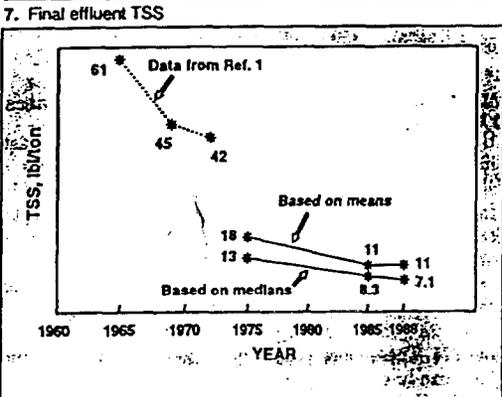
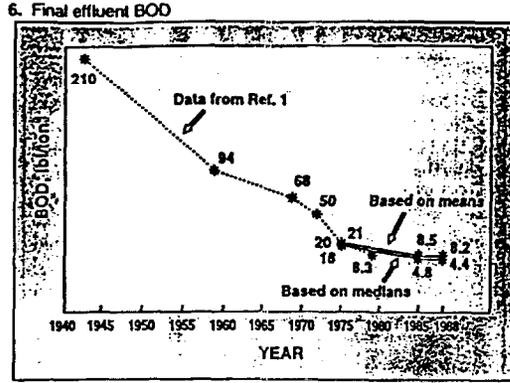
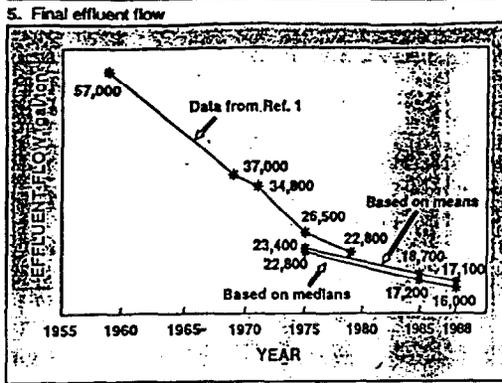
The fact that wastewater flows are dropping faster than the corresponding BOD loads suggest that raw waste concentrations are increasing. This could have important implications to wastewater treatment practices and concentration-based discharge limitations.

Wastewater TSS to treatment

The amounts of TSS contained in the industry's wastewater before treatment are shown in Fig. 4.

These data suggest a modest reduction in wastewater

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the reductions in water use, wastewater flow to treatment, and final effluent flow are comparable.

Final effluent BOD

The amounts of BOD estimated to be contained in the industry's final discharges in 1988, 1985, and 1975 are shown in Fig. 6. These figures have been calculated by applying the mean and median treated wastewater BOD loads for each category to all production in that category, whether the waste is treated on-site or by a publicly owned treatment works (POTW). This approach assumes that the amount of treatment accomplished in POTWs is comparable to that in the industry's wastewater treatment plants. This approach is consistent with that used in earlier efforts to estimate industry average discharges of BOD (and TSS) that are used as a basis for comparison to the new data discussed herein. The substantial differences between the means and medians suggest final effluent BOD loads to be very poorly described by the normal distribution, being instead highly skewed to the right. This observation conforms to findings in earlier NCASI studies of the statistical distributions useful for analyzing effluent quality data (2).

Discharges of BOD to the environment are reduced dramatically by the use of biological treatment. The paper industry began to employ biological treatment in the 1950s, with application becoming almost universal in the late 1970s. Accordingly, the reductions in BOD discharges accomplished from 1975 and earlier levels are especially impressive. The amount of BOD discharged per unit of production in 1988 was only one-third to one-quarter of that discharged in 1975, and less than 5% of that in 1943.

The data suggest effluent BOD loads were reduced by 4-8% in the relatively short period of 1985 to 1988. These improvements almost certainly reflect continued efforts to improve wastewater treatment plant performance.

Final effluent TSS

The amounts of TSS estimated to be contained in the industry's final discharges in 1988, 1985, and 1975 are shown in Fig. 7. As in the case of the final BOD values, these figures have been calculated by applying the mean

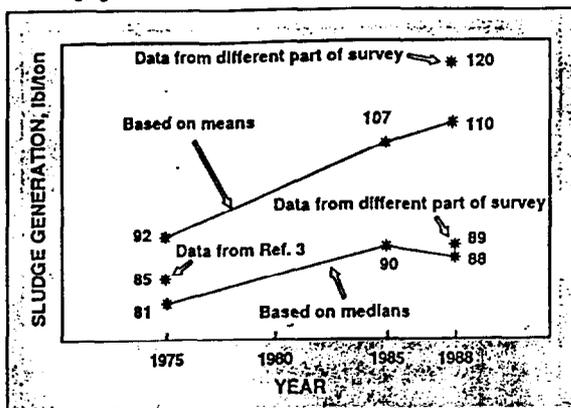
TSS going to treatment between 1985 and 1988 (there was no reduction estimated from mean values but a 10% reduction estimated from median values), and a reduction from 1975 to 1988 of 9-10%. Since before effluent quality data were generated, the paper industry has employed technologies to capture and, where feasible, reuse the solids contained in process wastewaters from papermaking. These efforts have provided steady reductions in the discharges of TSS in industry effluents. For the most part, we can assume that the reductions in raw waste suspended solids loads documented in Fig. 4 are the result of expanded efforts to (a) capture and reuse solids where possible and (b) segregate other solids from the wastewater stream, facilitating their handling and disposal.

Final effluent flow

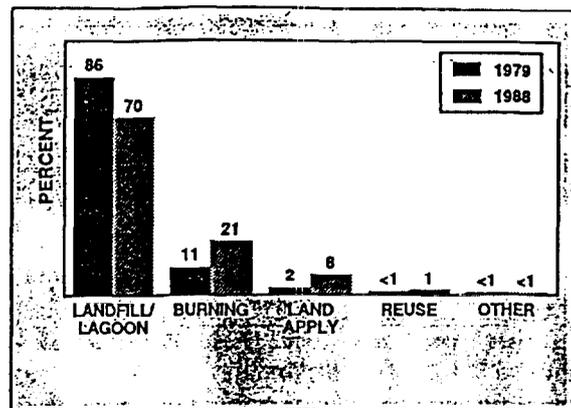
The overall industry final effluent flow rates calculated from this survey for 1988, 1985, and 1975 are shown in Fig. 5. The figure also contains previously published data for 1979, 1975, 1971, 1969, and 1959 (1).

The data indicate that the overall industry 1988 final effluent flow per ton of production had decreased by 7-9% since 1985, 25% since 1979, 27-36% since 1975, 51% since 1971, 54% since 1969, and 70% since 1959. As expected,

8. Sludge generation



9. Sludge disposition (1979 data from Ref. 1)



and median treated wastewater TSS loads for each category to all production in that category, whether the waste is treated on-site or by a publicly owned treatment works.

As was the case for the final effluent BOD data, the substantial differences between the means and medians suggest final effluent TSS loads to be very poorly described by the normal distribution, being instead highly skewed to the right. Again, this observation conforms to findings in earlier NCASI studies of the statistical distributions useful for analyzing effluent quality data (2).

During the period before the widespread adoption of biological treatment (i.e., when primary treatment was the norm), reductions in discharges of solids in final effluents were more strongly related to reductions in solids losses in untreated wastes than is the case today. Solids in untreated wastes may still influence the levels of solids in biologically treated effluents, especially when solids such as coating clays are involved. Usually, however, biological treatment systems greatly diminish the dependence of final TSS levels on untreated waste TSS levels.

Biological treatment requires the growth of additional solids (biological solids). It is these solids that comprise the majority of those contained in biologically treated effluents. However, biological treatment systems also provide for efficient solids removal, usually accomplishing additional reductions in discharges of TSS compared to primary-treated wastewaters.

Available data indicate that 1988 TSS discharges per unit of production had been reduced by approximately 40% since 1975, and by over 80% since 1965. Again, the dramatic reductions from 1975 and earlier final effluent loads can be attributed in part to the use of biological treatment, which, although in widespread use in the paper industry before 1975, became almost universal in its application in the late 1970s.

The improvements in effluent quality did not cease, however, upon the widespread adoption of biological treatment by the paper industry. The continued efforts to reduce waste loads and improve treatment plant performance are demonstrated by the reductions documented during the three-year period from 1985 to 1988. Even over this short time, it appears that final discharges of BOD

and TSS per unit of production were reduced by perhaps 5% or more.

Wastewater treatment sludge generation rates

Because NCASI's survey was focused on solid waste management, it was possible to generate estimates of sludge generation by several different methods. The information in Fig. 8, however, was generated using the same methods used in the preceding sections on water use and wastewater loads unless otherwise indicated.

These data suggest relatively little change in sludge generation rates from 1985 to 1988, and 1988 sludge generation rates that are 9–41% percent higher than those in 1975. These increases in sludge generation rates since 1975 can be explained by the corresponding reductions in final effluent BOD and TSS loads that have been accomplished over the same period.

The generation rates in Fig. 8 are presented in terms of dry sludge solids. Although not estimated, it is likely that the wet weights and volumes of sludges being managed have actually decreased dramatically since 1975 because of the installation of mechanical sludge dewatering equipment at many mills where it was not previously employed.

Beneficial uses of wastewater treatment sludges

The paper industry is expanding its efforts to apply wastewater treatment sludges to beneficial uses. The data in Fig. 9 indicate the industry is relying less on landfill or lagoon disposal and more on burning for energy, applying to land for soil conditioning, and other recycle/reuse/by-product opportunities that represent beneficial uses of wastewater treatment sludges.

Because of the low response rates from recycled paperboard mills, the data in Fig. 9 do not sufficiently reflect the extent to which primary sludges are used as furnish at the recycled paperboard mills where they are generated. The extent to which recycled paperboard mills reuse primary sludge was documented in a 1983 survey by NCASI's Central-Lake States Regional Center of the mills in that part of the country. Thirty-three recycled

paperboard mills were contacted, of which 27 were generating sludge. The remaining six were either discharging untreated wastewaters to publicly owned treatment works or were employing treatment systems that did not allow sludges to be collected for separate disposal or reuse. Eighteen mills were reusing sludges in the production process. These 18 comprise more than half of the recycled paperboard mills contacted and two-thirds of those generating sludges in a form that would allow them to be reused. Sludges are also commonly reused at mills producing corrugating medium or linerboard from wastepaper.

Summary

The NCASI survey revealed the following:

1. Data from this survey and other sources document reductions in water use and effluent flows of approximately 30% between 1975 and 1988. In 1988, it required 70% less water to make a ton of paper than in 1959. Even in the short three-year period from 1985 to 1988, water use and effluent flow rates were reduced by 7-9%. Based on the data from this survey, the industry average water use in 1988 was approximately 16,000 to 17,000 gal/ton.
2. Raw waste BOD and TSS loads were reduced by approximately 10% between 1975 and 1988.
3. The amount of BOD discharged in final effluents per unit of production in 1988 was only one-third to one-quarter of that discharged in 1975, and less than 5% of that in 1943.
4. Available data indicate that 1988 TSS discharges in final effluents per unit of production had been reduced by approximately 40% since 1975, and by over 80% since 1965.
5. Even in the short period of 1985 to 1988, it appears that final discharges of BOD and TSS per unit of production were reduced by approximately 5%.

6. The reductions in final BOD and TSS loads have been accompanied by corresponding increases in sludge generation rates.
7. Whereas 86% of the industry's sludge was landfilled or lagooned in 1979, in 1988 this had been reduced to 70%. The recovery of energy from wastewater treatment sludges has grown in the last decade. In 1979, 11% of the paper industry's sludge was being burned, whereas 21% was being managed in this way in 1988. The use of land application has also grown, with 8% of the industry's sludge being land applied in 1988 compared to 2% in 1979. In some sectors of the industry, most notably recycled paperboard, one-half or more of the mills are reusing sludge directly in the production process. □

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1. NCASI Special Report 83-09, A Compilation of Data on the Nature and Performance of Wastewater Management Systems in the Pulp and Paper Industry, NCASI, New York, August 1983.
2. NCASI Technical Bulletin No. 355, A Review of Variability in Effluent Quality Discharged by Selected Pulp and Paper Industry Sources, NCASI, New York, August 1981.
3. Blosser, R. O. and Miner, R. A., Environmental Protection in the '90s Symposium Proceedings, EuCePa, Helsinki, Finland, 1986.

The compilation and analysis of this information would not have been possible without the skillful and persistent efforts of Laurel Eppstein and Steven Norton, research assistants at NCASI's Central-Lake States Regional Center. Their contributions are gratefully acknowledged.

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Presented at the TAPPI 1991 Environmental Conference.

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FLAMMABILITY 1
REACTIVITY 0

8332 Dantogard

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MATERIAL Dantogard	DATE ISSUED 04/14/95 - Rev.	DOT HAZARD CLASSIFICATION Non-hazardous
CAS NO. Mixture	SUPERCEDES 02/10/94	DOT SHIPPING NAME Not regulated
FORMULA Mixture		DOT LABEL None

CHEMICAL NAME (Active) 1,3-Dihydroxymethyl-5,5-Dimethylhydantoin; DMDM Hydantoin; 1,3-Dimethylol-5,5-dimethylhydantoin; 1,3-Di(hydroxymethyl)-5,5-dimethyl-2,4-imidazolidinedione

***** I - INGREDIENTS *****

	APPROXIMATE WEIGHT %	TWA/TLV
1,3-Dihydroxymethyl-5,5-Dimethylhydantoin (CAS No. 6440-58-0)	32	None established
Hydroxymethyl-5,5-dimethylhydantoin (CAS No. 27636-82-4)	7.5	None established
Formaldehyde (CAS No. 50-00-0)	1.5	0.75 ppm (OSHA-PEL) 2 ppm (OSHA-STEL) 1 ppm (ACGIH-TLV) 2 ppm (ACGIH-STEL)
Water (CAS No. 7732-18-5)	59	None established

***** II - PHYSICAL AND CHEMICAL PROPERTIES *****

APPEARANCE Water white liquid	pH 6.5 - 7.5
VISCOSITY Not known	ODOR Slight formaldehyde
BOILING POINT Not known	MELTING OR FREEZING POINT -5°C
VAPOR DENSITY (Air=1) Not applicable	VAPOR PRESSURE (mm Hg) Not known
PERCENT VOLATILE (by weight) 59	SOLUBILITY IN WATER Soluble
EVAPORATION RATE (Butyl Acetate=1) <1	SPECIFIC GRAVITY (WATER = 1) 1.1 @ 25°C

***** III - FIRE AND EXPLOSION INFORMATION *****

FLASH POINT >200°F	AUTO IGNITION TEMPERATURE Not known
LOWER EXPLOSION LIMIT (%) Not applicable	UPPER EXPLOSION LIMIT (%) Not applicable
EXTINGUISHING MEDIA FOAM X	ALCOHOL FOAM
DRY CHEMICAL X	WATER X
	CO ₂ X
	OTHER

001123

SPECIAL FIRE FIGHTING PROCEDURES:

Must wear NIOSH/MSHA approved self-contained breathing apparatus and protective clothing. Cool fire-exposed containers with water spray.

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***** IX - TOXICOLOGY INFORMATION (continued) *****

For Monomethylol-5,5-dimethylhydantoin:

- oral LD₅₀ (rat): 2700 mg/kg
- eye irritation (rabbit): mild irritant
- skin irritation (rabbit): non-irritant
- inhalation: Levels of respiratory irritation not established. Based on results with a closely related chemical, a potential respiratory irritation should be anticipated as for nuisance particulates.

***** X - MISCELLANEOUS AND REGULATORY INFORMATION *****

FEDERAL LEVEL REGULATIONS:

This is an EPA FIFRA registered pesticide (EPA Registration No. 6836-119). This material can only be used commercially in the EPA registered application(s) noted on the product label.

TOXIC SUBSTANCES CONTROL ACT (TSCA INVENTORY) STATUS:

Not found on the U.S. EPA TSCA inventory. For use only in products that are not regulated under TSCA (such as EPA FIFRA registered and FDA regulated products), or to be used in research and development (R&D) only by technically qualified individuals.

CERCLA (Comprehensive Environmental Response, Compensation and Liability Act of 1980 requires notification of the National Response Center (Telephone 800-424-8802) in the event of a release of quantities of the following hazardous materials contained in this product, if the release is equal to or greater than the Reportable Quantities (RQs) listed in 40 CFR 302.4:

<u>Chemical Name</u>	<u>CAS Number</u>	<u>Typical Maximum Concentration</u>
Formaldehyde	50-00-0	1.5%

SARA Title III, Sections 302/304 (Superfund Amendments and Reauthorization act of 1986) - This act requires emergency planning, including agency notification, for possible release of the following components of this material, based upon the Threshold Planning Quantities (TPQs) and release Reportable Quantities (RQs) listed for the Components in 40 CFR 355:

<u>Chemical Name</u>	<u>CAS Number</u>	<u>Typical Maximum Concentration</u>
Formaldehyde	50-00-0	1.5%

SARA Title III Sections 311/312 - This act requires reporting under the Community Right-to-Know provisions due to the inclusion of the following components of this material in one or more of the five hazard categories listed in 40 CFR 370:

<u>Chemical Name</u>	<u>CAS Number</u>	<u>Hazard *) Categories</u>
Formaldehyde	50-00-0	A, C, F

*) The five hazard categories are as follows: F-FIRE HAZARD; S- SUDDEN RELEASE OF PRESSURE; R-REACTIVE; A-IMMEDIATE (ACUTE) HEALTH HAZARD; C-DELAYED (CHRONIC) HEALTH HAZARD

001127

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PAGE 4 OF 6

***** VII - PERSONAL PROTECTION INFORMATION *****

VENTILATION TYPE

In processes where mists or vapors may be generated, proper ventilation must be provided in accordance with good ventilation practices.h good ventilation practices.

RESPIRATORY PROTECTION

In processes where mists or vapors may be generated, a NIOSH/MSHA jointly approved respirator is advised in the absence of proper environmental controls.

PROTECTIVE GLOVES

Rubber or neoprene, when needed, to prevent skin contact.

EYE PROTECTION

Wear chemical splash goggles where there is a potential for eye contact. Use safety glasses with side shields under normal use conditions.

OTHER PROTECTIVE EQUIPMENT

Eye wash; safety shower; protective clothing (long sleeves, coveralls or other, as appropriate), when needed, to prevent skin contact.

***** VIII - STORAGE AND HANDLING *****

PRECAUTIONS FOR STORAGE AND HANDLING:

Keep containers closed until used.

Store in a warm warehouse. Avoid storing below 60°F to prevent crystallization. Keep from freezing.

***** IX - TOXICOLOGY INFORMATION *****

For this product (Dantogard - 40% aqueous solution of 1,3-Dihydroxymethyl-5,5-dimethylhydantion):

- oral LD₅₀ (rat): 4200 mg/kg
- dermal (rabbit): Mild irritant
- eye irritation: Mild irritant to rabbit eyes
- inhalation LC₅₀ (rat): for four hours >5 mg/l nominal concentration.

For a 55% active aqueous solution of this product:

- oral LD₅₀ (male rat): 2700 mg/kg
- dermal LD₅₀ (rabbit): greater than 20000 mg/kg
- inhalation LC₅₀ (rat, 1 hour): greater than 204 mg/liter
- mutagenic activity: Positive in two strains of Salmonella.
Positive in mouse lymphoma, Chinese hamster ovary and unscheduled DNA synthesis (rat liver cells). Negative in unscheduled DNA synthesis infusion and in vivo DNA damage assay.
- skin irritation (rabbit): primary irritation score 1.5 (mild irritant)
- eye irritation (rabbit): unrinsed - mild to moderate irritation, reversible in 6-7 days; rinsed - no irritation
- not teratogenic via oral or dermal routes

001126

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PAGE 6 OF 6

***** X - MISCELLANEOUS AND REGULATORY INFORMATION (continued) *****

FEDERAL LEVEL REGULATIONS (continued):

SARA Title III Section 313 - This act requires submission of annual reports of the releases of the following components of this material if the threshold reporting quantities as listed in 40 CFR 372, are met or exceeded:

<u>Chemical Name</u>	<u>CAS Number</u>	<u>Typical Maximum Concentration</u>
Formaldehyde	50-00-0	1.5%

STATE RIGHT-TO-KNOW REGULATIONS:

CALIFORNIA PROPOSITION 65 - Components present in this material which the State of California has found to cause cancer, birth defects or other reproductive harm are as follows:

<u>Chemical Name</u>	<u>CAS Number</u>	<u>Typical Maximum Concentration</u>
Formaldehyde	50-00-0	1.5%

MASSACHUSETTS Right-to-Know - The following components of this material are included in the Massachusetts Substance List and are present at or above reportable levels:

<u>Chemical Name</u>	<u>CAS Number</u>	<u>Typical Maximum Concentration</u>
Formaldehyde	50-00-0	1.5%

MICHIGAN Critical Materials - The following components of this material are included in the Michigan Critical Materials List:

<u>Chemical Name</u>	<u>CAS Number</u>
Formaldehyde	50-00-0

NEW JERSEY Right-to-Know - The following components of this material are included in the New Jersey Hazardous Substance List and are present at or above reportable levels:

<u>Chemical Name</u>	<u>CAS Number</u>	<u>Typical Maximum Concentration</u>
Formaldehyde	50-00-0	1.5%

PENNSYLVANIA Right-to-Know - The following components of this material are included in the Pennsylvania Hazardous Substance List and are present at or above reportable levels:

<u>Chemical Name</u>	<u>CAS Number</u>	<u>Typical Maximum Concentration</u>
Formaldehyde	50-00-0	1.5%

001128