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Reprints:
October 1980 - December 1986

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

NIOSH ALERTS
REPRINTS: OCTOBER 1980 - DECEMBER 1986

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SEPTEMBER 1987

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DHHS (NIOSH) Publication No. 87-119

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PREFACE

Alerts are produced by the National Institute for Occupational Safety and Health (NIOSH), CDC, Atlanta, Georgia. The purpose of an Alert is to provide a short narrative of a new finding which has implications for prevention. The Alert relays a sense of urgency and requests the assistance of those responsible for action, in helping to prevent the identified problem. The Alert can also be used to reaffirm the magnitude of an already recognized problem. These documents contain information that can be used to reduce injuries or illnesses and to stimulate research on effective preventive measures. The primary audience is intended to be those persons with ability to intervene in the work environment to quickly reduce risks. This includes plant managers, supervisors, worker representatives, and the actual workers at risk, as well as the community of health and safety professionals.

Since 1980, 13 Alerts have been issued. These Alerts have been reprinted in this publication for the convenience of those who would like a complete series for reference purposes. The Alerts have been reprinted as originally published and do not contain information that may have become available since the date of publication.

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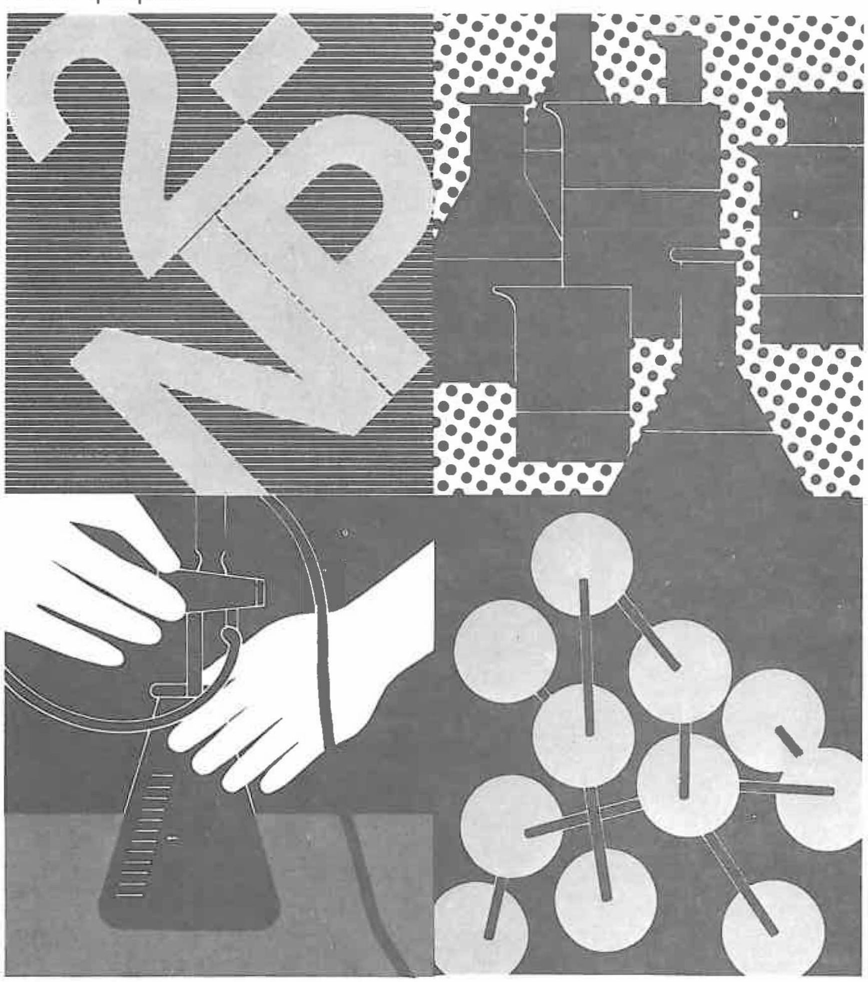
2-Nitropropane



HEALTH HAZARD ALERT - 2-NITROPROPANE (2-NP)

OSHA and NIOSH conclude that 2-nitropropane (2-NP) is a confirmed carcinogen in laboratory rats (1,2,3). In 1977, NIOSH summarized the carcinogenic potential of 2-NP in Current Intelligence Bulletin #17 (4). Since then data have been developed which reinforce and expand the original findings. As a confirmed animal carcinogen, 2-NP has the potential to cause cancer in humans. This document summarizes the cancer studies of 2-NP in laboratory animals and its toxic effects in humans. It recommends that worker exposure to 2-NP be reduced to the lowest feasible levels. The document recommends actions, procedures, and medical programs that should be used to protect workers from exposure to 2-NP.

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for John ... [signature]

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DHHS (NIOSH) Publication No. 80-142

Acknowledgements

The Directorate of Technical Support, Occupational Safety and Health Administration (OSHA), and the Division of Criteria Documentation and Standards Development, National Institute for Occupational Safety and Health (NIOSH), had primary responsibilities for this document. Dr. James R. Beall of the Directorate of Technical Support, OSHA, served as the project manager. Personnel from OSHA who assisted with the development of the document include: Victor Alexander, M.D., Ching-Tsen Bien, M.S., Chia Chen, Ph.D., Peter Infante, Dr. P.H., Patricia Marlow, Ph.D., and Elisa Braver, M.H.S. Personnel from NIOSH who assisted with the development of the document include: Nelson Leidel, Sc.D., Trent Lewis, Ph.D., and A.W. Thomas, B.S.

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October 1, 1980

Health Hazard Alert--2-Nitropropane

Production and Exposure

Solvent systems containing 2-NP are used in coatings (e.g., vinyl, epoxy paints, nitrocellulose, and chlorinated rubber), printing inks, and adhesives. It is also used as a solvent in food processing for fractionation of a partially saturated vegetable oil. Occupational exposure to 2-NP may occur in many industries including industrial construction and maintenance, printing (rotogravure and flexographic inks), highway maintenance (traffic markings), shipbuilding and maintenance (marine coatings), furniture, and plastic products. About 185,000 workers in the U.S. are exposed to 2-NP during its production and use. Commercial Solvents Corporation (CSC) was the only producer of 2-NP until that corporation was purchased about 5 years ago by International Minerals and Chemical Corporation (IMC). International Minerals and Chemical Corporation is now the sole producer of 2-NP. 2-Nitropropane was manufactured in a pilot plant in Peoria, Illinois, from 1940 to 1955. Since 1955, it has been manufactured in a plant in Sterlington, Louisiana. Of the estimated 30 million pounds of 2-NP produced annually, 12 million are sold domestically. The remainder is either used internally at IMC or exported. Major distributors of 2-NP, other than Commercial Solvents Corporation, include Amsco Division of Union Oil Company of California, Industrial Chemicals and Solvents Division of Ashland Chemical Company, and Thompson Hayward Chemical Company (4).

Characteristics

2-Nitropropane (CAS No. 000 79-46-9; RTECS No. TZ5250000) is a clear colorless liquid with a pleasant odor. The molecular formula of 2-NP is $CH_3CH(NO_2)CH_3$, the molecular weight is 89.09 and the specific gravity is 0.992 (5,6). The melting point of 2-NP is -93°C, the boiling point is 118-120°C, and the solubility in water is 1.7 ml/100 ml at 25°C. 2-Nitropropane is soluble in many organic solvents including chloroform. The vapor pressure of 2-NP is 20 mm Hg at 25°C and the flash point is 103°F (39.4°C) (6). The lower flammability limit is 2.6% by volume in air (7). Its vapors may form an explosive mixture with air.

Synonyms for 2-NP include dimethylnitromethane, isonitropropane and nitroisopropane. Trade names for 2-NP include Ni-Par S-20TM (a commercial grade 2-NP) and NiPar S-30TM (mixtures of 1-nitropropane and 2-NP) (4).

Carcinogenicity Studies

Data from two carcinogenesis bioassay studies are available. One of these studies is completed (1,2). The other is ongoing (3). Both show that 2-NP is carcinogenic in rats. In the completed study, male Sprague-Dawley rats were exposed to 2-NP for 7 hours/day, 5 days/week for 6 months in whole body chambers (1,2). Fifty rats were exposed at 207 ppm, 50 at 27 ppm, and 50 were unexposed. Liver cancers (hepatocellular carcinoma) were observed in all 10 rats killed after 6 months of exposure at 207 ppm of 2-NP. No tumors were observed in any other animals in this study, including controls. Rats exposed at 207 ppm developed other adverse liver changes such as hepatocellular hypertrophy, hyperplasia, and necrosis after 3 months. In the second uncompleted study (3), both sexes of Sprague-Dawley rats were exposed to 2-NP vapors at 200 ppm, 100 ppm, or 25 ppm for 7 hours/day, 5 days/week for up to 6 months. Nine of 10 rats exposed for 6 months at 200 ppm and held unexposed for 6 more months had metastatic liver carcinomas. According to preliminary data male rats exposed at 100 ppm also developed liver tumors (8). At the end of 22 months no malignancies or any significant pathologic changes were observed in the livers of any of the male or female rats exposed at 25 ppm. Focal areas of hepatic cellular nodules were noted in 3 of 250 control animals and 13 of 249 exposed animals. Other microscopic observations included focal cytoplasmic vacuolization of hepatocytes and liver congestion (18).

In addition to carcinogenic changes, 2-NP causes other toxic changes in laboratory animals and in humans (1-3,9-15).

Studies of humans who were accidentally exposed to 2-NP show that brief exposure to high concentrations may be harmful. One report about two workers attributes the death of one and liver damage in both to high level exposures to 2-NP that occurred while they painted the inside of a tank (9). They had used a zinc-epoxy paint diluted with 2-NP and ethylglycol (2-ethoxyethanol). Another report describes the deaths of four men who were working in confined spaces with paint, surface coating, and polyester based resin products containing 2-NP (15). All four workers had liver damage and destruction of hepatocytes. The authors attributed the deaths to overexposure to 2-NP but admitted that other solvents might have played a role since 2-NP was not identified by toxicological analysis (15). Continuing exposure to concentrations of 20 to 45 ppm of 2-NP caused nausea, vomiting, diarrhea, anorexia, and severe headaches in workers in one plant (12). In another instance, toxic hepatitis developed in construction workers applying epoxy resins to the walls of a nuclear power plant (13). Although the hepatitis was attributed to a known hepatoxin, p,p'-methylenedianiline (4,4'-diaminodiphenylmethane), it could have resulted from the 2-NP that the men used to wash the epoxy resins from their skin.

Workers may not be able to detect 2-NP by its odor, even in the presence of potentially hazardous concentrations. One report states that humans cannot detect 2-NP at 83 ppm by its odor (10). Another states that 2-NP cannot be detected by its odor until the concentration is about 160 ppm (15).

In 1979, an epidemiological study of workers exposed to 2-NP was reported by the International Minerals and Chemical Corporation (16). The study included all 1,481 employees who worked at the Sterlington, Louisiana, plant between 1955 when 2-NP production began and the study cutoff date of July, 1977. The company defined the exposure of each employee in the study group as direct, indirect, or not exposed. Since formal industrial hygiene monitoring of work areas was not performed until 1977, individual exposure classifications were based on job titles rather than actual exposure data. Interpretation of the study results is further hampered by several factors, including: (1) the lack of sufficient time since onset of exposure for tumor development, (2) the limited number of workers in the study with long exposures (15 years), and (3) the small number of deaths among the group studied. The authors conclude that "analysis of these data does not suggest any unusual cancer or other disease mortality pattern among this group of workers." They appropriately note, however, that "both because the cohort is small and because the period of latency is, for most, relatively short, one cannot conclude from these data that 2-NP is non-carcinogenic in humans" (16).

There are, in addition, a number of unexplained findings with respect to cancer mortality observed among employees whom the company has classified as not exposed to 2-NP. When the mortality figures for all males, regardless of exposure catagory, are combined, there were 4 deaths from lymphatic cancer where only 1 was expected.

Among the total of 147 female employees there were 8 deaths from all causes compared to 2.9 expected deaths, and 4 deaths from cancer compared to 0.8 expected. Finally, the authors report that 7 deaths in the small study cohort were observed from sarcomatous cancer, which is a relatively rare form of malignancy. This number seems unusually high. However, it was not possible to generate an expected number of deaths for comparison to determine statistically if the sarcomatous cancers were in excess because they cannot be broken out in the standard method of reporting and classifying deaths. The International Classification of Diseases (ICD), used in the study, does not have a unique code for those cancers. The authors recommend that follow-up of the cohort be continued and that the data be reanalyzed periodically. The company has committed itself to a program that includes these suggestions. OSHA and NIOSH agree that the present study is inconclusive, and that it is appropriate to continue follow-up and reanalysis to confirm or to modify the observations made thus far.

Recommendations

2-Nitropropane should be handled in the workplace as a potential human carcinogen. OSHA's current Permissible Exposure Limit for 2-NP is 25 ppm or 90 mg/m^3 (8-hour, time-weighted averages). Evidence of carcinogenicity was not considered in setting this limit. Because 2-NP has now been shown to be carcinogenic in rats, occupational exposure to it should be reduced to the lowest feasible levels. Methods of sampling for 2-NP in air include use of a sorbent tube containing Chromosorb 105 to trap organic vapors (17). Gas chromatographic and other methods for analyzing concentrations of 2-NP at levels of 300 ppb are also available (17).

To protect workers from exposure to 2-NP, there are several actions that employers, employees, and their physicians should take.

Table I contains acceptable respirators that may be used to reduce exposure to 2-NP by inhalation.

I. Employers Should:

1. Inform all employees working with 2-NP, or mixtures containing 2-NP, of the possible adverse symptoms or health effects that could result from exposure to it. Provide all employees with a copy of this hazard report.

2. When possible, substitute a solvent that does not contain 2-NP. Caution should be exercised in selecting a substitute for 2-NP, giving full consideration to the possible toxic effects of the replacement.

3. Provide all employees with potential exposure to 2-NP with a medical monitoring program that includes work history and medical examinations with specific emphasis on liver function tests. Physicians in this program should be provided with a copy of this Health Hazard Alert.

4. Provide wash or shower areas as appropriate for employees to decontaminate themselves after leaving the work area where exposure to 2-NP occurs.

5. Establish where possible restricted areas for the manufacture, filling operations, use, handling or storage of 2-NP to reduce exposure of employees not directly involved with these operations. Access to these restricted areas should be limited to employees who have been properly informed of the potential hazards of 2-NP exposure and instructed in the proper control measures.

6. Establish appropriate engineering controls. The most effective way to control any contaminant is the use of a closed system. Engineering controls may include the use of walk-in hoods or specific local exhaust ventilation. Due to the explosive potential of 2-NP vapor, ignition-proof ventilation systems should be selected. Suitable collectors should be used to prevent pollution of adjacent work areas.

7. Provide MSHA/NIOSH-approved personal respiratory protective devices to be used as an interim measure to control the inhalation of 2-NP while engineering controls are being installed. Respiratory protective devices may be used in areas where exposure to 2-NP occurs infrequently or during emergencies. Table I contains respirators that may be used to reduce exposure to 2-NP by inhalation.

8. Provide full-body clothing for protection against splashes of 2-NP. Care should be used to select appropriate protective clothes since 2-NP may dissolve or penetrate many materials (19). The protective clothing should be left at the point of exit when an employee leaves the restricted area. At the end of the work day, employees should place the protective clothing in a suitably marked and closed container for disposal or laundering. Laundry personnel should be made aware of the potential hazards from handling contaminated clothing.

II. Employees Should:

1. Use the correct safety equipment and protective devices provided by the employer. Contaminated clothing should be left at the worksite and laundered by the employee as noted in I (8).

2. Wash all exposed areas of the body upon leaving the restricted area.

3. Report signs or symptoms of health problems to your physician. If a private physician is used, he/she should be given a copy of this Health Hazard Alert.

III. As part of the medical surveillance program presented under recommendation I-3, physicians should:

1. Obtain a careful occupational and exposure history.

2. Inquire about constitutional complaints including nausea, vomiting, diarrhea, dizziness, anorexia, and headache.

3. Perform a physical examination with emphasis on the cardiovascular, renal, and hepatic systems.

4. Order laboratory studies of blood, particularly for liver and kidney function, and a urinalysis with microscopic examination.

5. Advise the employee of the results of the medical examination and laboratory analyses.

TABLE 1. RESPIRATOR SELECTION FOR 2-NITROPROPANE*

Maximum Exposure Concentration (or Conditions of Use)	Recommended Respirator*
Not in excess of 1,000 ppm	Half-mask positive-pressure supplied air respirator. Full facepiece is required if eye irritation is experienced.
Between 1,000 and 2,000 ppm	Positive-pressure supplied air respirator with full facepiece, helmet or hood.
Over 2,000 ppm or unknown concentration	1. Full facepiece positive-pressure self-contained breathing apparatus.
	2. Full facepiece positive-pressure supplied air respirator with an auxiliary positive-pressure self-contained air supply.
Firefighting Situations	Full facepiece positive-pressure self-contained breathing apparatus.
Escape Situations	Any full facepiece, self-contained breathing apparatus.

*Note: Respirators using canisters that contain oxidation promoting catalysts should never be used with 2-NP (19).

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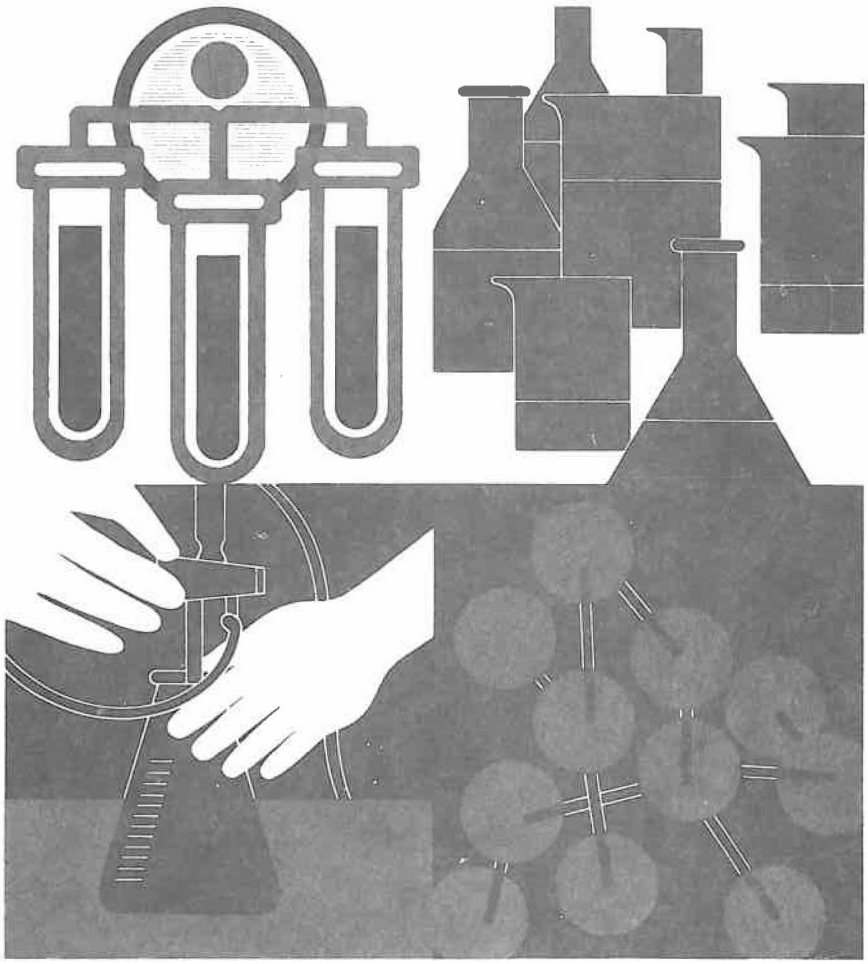
health hazard alert

OSHA NIOSH

Benzidine-, o-Tolidine-, and o-Dianisidine- Based Dyes



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Health Hazard Alert:

Benzidine-, o-Tolidine-, and o-Dianisidine-Based Dyes

DHHS (NIOSH) Publication No. 81-106

U.S. Department of Labor
Occupational Safety and Health Administration

U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

December 1980

Recent data from animal tests, case reports, and other sources about the carcinogenic effects and metabolism of benzidine-, o-tolidine-, and o-dianisidine-based dyes have come to the attention of OSHA and NIOSH. Both agencies have reviewed the data and conclude that the findings establish the potential of these dyes to cause cancer in humans.

OSHA and NIOSH conclude that persons working with these dyes should be aware of the potential health hazards that could result from excessive exposure to them. The intent of this document is to summarize the information available on the carcinogenic effects and metabolism of benzidine-, o-tolidine-, and o-dianisidine-based dyes and to provide guidance so that employers, employees, and physicians may work together to reduce potential health hazards that could result from excessive exposure to these dyes.

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ACKNOWLEDGMENTS

The Directorate of Technical Support of the Occupational Safety and Health Administration (OSHA) and the Division of Criteria Documentation and Standards Development of the National Institute for Occupational Safety and Health (NIOSH) had primary responsibility for this document. Dr. James R. Beall of the Directorate of Technical Support, OSHA, served as the project manager. Personnel from OSHA who assisted with the development of the document include: Victor Alexander, M.D.,Thomas Markham, M.D., Ching Bien, Patricia Marlow, Ph.D., Abbie Gerber, M.S. and Peter Infante, Dr. P.H. Personnel from NIOSH who assisted with development of the document include: Irwin Baumel, Ph.D., Frank Mackison, Arthur Gregory, Ph.D., and Imogene Sevin, Ph.D.

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BENZIDINE-, o-TOLIDINE-, AND o-DIANISIDINE-BASED DYES

Health Hazard Alert

SUMMARY

OSHA and NIOSH have reviewed the literature on benzidine-based dyes. Available studies indicate that some benzidine-based dyes cause cancer in experimental animals and are converted in animals and humans to benzidine. From the accumulated evidence, OSHA and NIOSH conclude that benzidine-based dyes are potential human carcinogens. In a Special Hazard Review, NIOSH has recommended that the commercial use of benzidine-based dyes be discontinued and appropriate substitutes be utilized. OSHA has concluded that exposure of workers to the dyes should be reduced to the lowest feasible levels. This should include discontinuing use of the dyes where possible.

There is evidence from animal studies that o-tolidine, o-dianisidine, and the two dyes based on o-tolidine are carcinogenic. There is preliminary evidence that dyes based on o-tolidine and o-dianisidine, except for metalized dyes based on o-dianisidine, may be metabolically converted to the parent compounds. Benzidine-based dyes may contain residual amounts of benzidine as well as other substances such as 4-aminobiphenyl, an OSHA-regulated carcinogen. Dyes manufactured from o-dianisidine and o-tolidine may also contain residual amounts of the respective parent compounds. Therefore, there may be a problem of contamination with carcinogenic materials in addition to concern for the metabolism of these dyes to carcinogenic substances. Dyes derived from o-tolidine and o-dianisidine should be handled with great care in the workplace, and exposure to them should be strictly limited. This Health Hazard Alert summarizes these biological effects and presents actions that should be taken to reduce worker exposure to these substances.

BACKGROUND

Benzidine-based dyes are defined as dyes that contain benzidine attached to other substituents by diazo linkages. Dyes based on o-tolidine contain o-tolidine (3,3'-dimethylbenzidine) attached to other substituents by diazo linkages. Dyes based on o-dianisidine (3,3'-dimethoxybenzidine) contain o-dianisidine attached to other substituents by diazo linkages. At least 16 benzidine-based, 8 o-tolidine-based, and 9 o-dianisidine-based dyes are produced currently in the United States. (1) The appendices contain a list of the dyes and a summary of major producers and importers of the dyes.

Estimates of the production and importation of these dyes by major companies are shown in Table 1. These estimates do not include importation or production by at least seven other companies.

Table 1

1978 Production and Importation of Dyes Made From Benzidine, o-Tolidine, and o-Dianisidine

Dyes From	Pounds (Presscake Basis)
Benzidine	1-2 million
o-Tolidine	800,000
o-Dianisidine	1,329,000

Source: Written communication from Dyes Environmental and Toxicology Organization, Inc. (DETO), Scarsdale, New York, September 24, 1979.

Thousands of workers involved in the production of dyes, textile, paper, and leather goods potentially are exposed to dyes based on benzidine, o-tolidine, and o-dianisidine. Because more than one of these dyes may be found concurrently in the same industry, it is difficult to count exposed workers and to define the extent of exposure to any specific dye.

The textile dyeing and finishing industry employed an estimated 75,400 production workers in July 1979; of these, about 7% were potentially exposed to these dyes. (2,3) In July 1979, the leather tanning and finishing industry employed 19,800 production workers of which 1,000 spray machine operators or colorers had the opportunity for exposure to the dyes. (3,4) NIOSH has estimated that about 79,200 workers in 63 occupations potentially are exposed to benzidine-based dyes. (5) The number of directly exposed workers is estimated by DETO to be less than 20,000. (6) Exposure to these compounds may occur by inhalation, ingestion, and skin absorption. (7,8,9) Definitive studies establishing the primary route of exposure have not been carried out.

Many of these dyes are complex mixtures, difficult to analyze, and may contain impurities that are carcinogenic. (10) For example, 4-aminobiphenyl, an OSHA-regulated carcinogen, and 2,4-diaminoazobenzene, an International Agency for Resarch on Cancer (IARC) documented carcinogen, (11) were found as impurities in a batch of C.I. Direct Black 38. (12) [See Note 1]

BENZIDINE-BASED DYES

Evidence of Carcinogenicity

In 1978, the National Cancer Institute (NCI) published the results of a 13-week subchronic feeding study of C.I. Direct Blue 6, C.I. Direct Black 38 and C.I. Direct Brown 95. (13,14) Two of these benzidine-based dyes induced both hepatic neoplastic nodules and hepatocellular carcinomas in male and female Fischer 344 rats; C.I. Direct Brown 95 induced tumors in female rats. (13,14) All of these dyes induced tumors within 5 weeks of the initial exposure. This is reported to be the shortest latency period for tumor development of any chemical studied in the NCI bioassay program. (5) Tumors did not develop in the control animals.

Korosteleleva et al. studied the effects of benzidine-based dyes fed to rats and mice. (15) Violet C 100% [See Note 2], a dye with a benzidine group in the molecule, induced microcholangiomas of the liver and other rare tumors in male rats; spontaneous tumors of this type were not observed in untreated rats.

Okajima et al. administered Direct Deep Black EX (C.I. Direct Black 38) in drinking water to male Wistar strain rats. This benzidine-based dye induced papillomas and carcinomas in the urinary bladder and carcinomas in the urinary bladder and carcinomas in the liver and colon. These lesions did not occur in control rats. (16)

An epidemiologic study by Yoshida et al. reported an association between employment in the dye industry and urinary bladder cancer in humans. Their review of the work histories of 200 male patients with bladder cancer revealed that 8.5% had worked in the dye industry and had been exposed to benzidine-based dyes. A review of the work histories of the 148 persons in the control group (randomly selected patients with urinary disease other than cancer) revealed that 1.4% had worked in dye industries. (17)

Note 1: C.I. indicates that the name is listed in the Colour Index, 3rd. ed., Society of Dyers and Colourists and the American Association of Textile Chemists and Colourists, Bradford, England, Vol. 1-6, 1971.

Note 2: Translation from the Russian. The 100% does not indicate that it was 100% active ingredient but that it was 100% of commercial dye strength. This is probably C.I. Direct Red 13.

Metabolism of Benzidine-Based Dyes to Benzidine

Evidence exists to indicate that benzidine-based dyes are converted to the carcinogen benzidine in laboratory animals and in humans.(10) The NCI bioassay of C.I. Direct Blue 6, C.I. Direct Black 38, and C.I. Direct Brown 95 for carcinogenicity included analyses of urine samples for benzidine from treated animals.(14) Urine samples from Fischer 344 rats were collected over 24-hour periods during weeks 4 and 12. Benzidine was detected in the urine of rats given benzidine-based dyes but not in the urine of the untreated control rats. As the amount of the dye fed to the rats increased, so did the amount of benzidine excreted in the urine. Analyses of the dyes prior to mixing in feed demonstrated no residual or contaminating benzidine. The data indicate that the benzidine in the urine resulted from the biotransformation of the dyes. Similar results were found by analyses of urine from $B_6C_3F_1$ mice.(14)

Rinde and Troll studied the metabolism of the benzidine-based dyes C.I. Direct Blue 6, C.I. Direct Black 38, C.I. Direct Brown 95, and C.I.Direct Red 28 in Rhesus monkeys.(18) Each monkey was gavaged with a single dose of one dye dissolved in dimethyl sulfoxide. Each of the dyes was administered in two different dose levels in separate experiments, except for C.I. Direct Red 28, which was given at only one level. Purified benzidine was administered at two levels in the same manner. Urine was collected over a 72-hour period from all the animals and pooled for assay. Urine collected from the monkeys before dosing was used to establish the control values. The authors found benzidine and a metabolite, monoacetyl benzidine, in the urine of the monkeys receiving the dyes. The control values were negative. They concluded that the dyes were converted to benzidine in vivo.(18) Korosteleva et al. found benzidine in the blood serum and tissues of rats fed Direct Red 13.(15) This indicated that the dye had been converted to benzidine.

Lynn et al. reported on the metabolism of the benzidine-based dyes C.I. Direct Blue 2, C.I. Direct Black 4, C.I. Direct Brown 2, C.I. Direct Orange 1, C.I. Direct Red 28, C.I. Direct Orange 8, and C.I. Direct Green 1 in female mongrel dogs and rats. (19) Each of five mongrel dogs was administered a dye orally and urine was collected at 24 hour intervals for 3 days. No trace of benzidine was detected in the dogs' urine 3 days after exposure. Some dogs were used more than once with a minimum of 1 week between dye exposures. Benzidine was recovered in the urine of each treated dog following the oral administration of the 7 dyes. Although some residual benzidine in each of the dyes had been detected prior to administration according to the authors, the amount of benzidine recovered in the urine exceeded that administered as a contaminant by at least 9 times. These findings suggest that the dye was converted to benzidine in the dog.

These same dyes were administered orally to two rats for 10 days. The urinary concentration of benzidine was not sufficient to permit chromatographic quantification but a benzidine metabolite, N-acetyl benzidine, was present in the urine of the rats following the administration of the dyes. This indicates that the dyes had been bioconverted to benzidine.

Genin administered subcutaneously or orally Direct Black 3 [See Note 3] and Direct Diazo Black C (C.I. Direct Blue 2) to albino rats.(20) Urine samples contained a metabolic product that the author identified as benzidine.

Yoshida and Miyakawa injected 4 benzidine-based dyes into sections of ligated intestines of rats and mice and incubated the preparations in vitro.(21) The dyes (C.I. Direct Black 38, C.I. Direct Green 1, C.I. Direct Red 17 and C.I. Direct Red 28) were free of residual benzidine prior to injection. Subsequent analyses indicated that the 4 dyes had been converted to benzidine.

There is evidence that humans metabolize certain benzidine-based dyes to benzidine. Korosteleva et al. obtained samples of blood serum from 101 female textile workers in the dye, printing, warehouse, and color room shops.(22) Analysis revealed benzidine in the blood of workers exposed to the dyes. Genin reported that benzidine was detected in the urine of 8 of 22 workers who dried and ground the benzidine-based dyes Direct Black 3 and C.I. Direct Blue 2. (20)

Boeniger surveyed workers at facilities that manufacture or use benzidine-based dyes including paper, textile, leather, and dye manufacturing facilities.(10) At one plant manufacturing benzidine-based dyes, 2 of 8 workers potentially exposed to these dyes excreted monoacetyl benzidine in their urine. At a second dye manufacturing facility, 4 workers provided urine samples; all 4 samples contained benzidine and 3 contained monoacetyl benzidine. Three of 7 workers at a textile dyeing and finishing facility also had benzidine and monoacetyl benzidine in their urine.

o-TOLIDINE and o-TOLIDINE-BASED DYES

Evidence of Carcinogenicity

The potential of o-tolidine to cause tumors has been recognized for several years.(23) Early experiments demonstrated its ability to induce tumors in Zymbal's gland (the specialized sebaceous gland of the auditory canal).(23) Subsequent experiments have shown that o-tolidine has the potential to induce tumors in a variety of organs and tissues.(24-28)

Perhaps the experiments by Pliss and Zabezhinsky reveal its carcinogenic potential most vividly.(25,26,27) These investigators demonstrated in a series of experiments that injections of o-tolidine in rats caused tumors in Zymbal's gland, mammary gland, skin, lung, thyroid, stomach, small intestine, hematopoietic tissue, uterus,

Note 3: The abstract given in the Russian journal translates the dye as Direct Black 3. It may be Direct Black 38.

and preputial gland. IARC reviewed the literature on o-tolidine and concluded that it was a systemic carcinogen in rats when given subcutaneously. (29)

Two o-tolidine-based dyes, trypan blue and Evans blue, were found to be carcinogenic in rats by two independent investigators. (30,31) During an 8-month study by Marshall, these two dyes were injected subcutaneously (trypan blue) and intraperitoneally (Evans blue) into rats.(30) Two different samples of the trypan blue were used in the study; one was 80% pure and the other was 34% pure. The rest of each sample consisted of inorganic salts and probably o-tolidine. Histiocytic tumors of the liver were found in 9 of 45 animals injected with trypan blue and in 10 of 40 rats receiving Evans blue. Reticular cell sarcomas of the lymph nodes and lymphosarcomas developed in treated animals. None of the tumors occurred at the injection sites; no tumors occurred in the two control groups of 20 animals.

Gillman and Gillman injected trypan blue into male and female rats (strain unspecified).(31) The rats were killed between days 70 and 100 and the lymph nodes were examined microscopically. Lymph nodes from control rats were used as a basis for anatomical comparison. Their study revealed that a wide variety of tumors developed in rats given trypan blue; the most common tumor was the histiocytoma.

IARC concluded that trypan blue is carcinogenic in rats when injected either intraperitoneally or subcutaneously.(11) IARC also stated that Evans blue is carcinogenic in rats when injected intraperitoneally.

Metabolism of o-Tolidine-Based Dyes to o-Tolidine

There is some evidence that dogs and humans may metabolize some o-tolidine based dyes to the parent compound. The evidence is not definitive in all cases because the parent compound, o-tolidine, may sometimes be present in the dyes as a trace level contaminant.(10) Lynn et al. studied the metabolism of four o-tolidine-based dyes, Direct Red 2, Direct Red 39, Direct Blue 25, and Acid Red 114, in female dogs and rats.(19) Dogs administered the latter two dyes excreted o-tolidine in the urine. The authors reported that the amount of o-tolidine recovered in the urine exceeded that which could have been contributed by o-tolidine contamination alone.

In the rat, Direct Blue 25 was metabolized to o-tolidine and excreted at concentrations comparable with those observed in dogs; only trace amounts were excreted following administration of Acid Red 114. Neither the dog nor the rat excreted quantifiable amounts of o-tolidine in the urine following the administration of Direct Red 39 or Direct Red 2.

Boeniger reported finding o-tolidine in the urine of two workers in a dye manufacturing plant.(10) These employees worked with o-tolidine-based dyes and not o-tolidine itself. The o-tolidine in the urine in both of these studies may have resulted from o-tolidine metabolism of the dyes or from o-tolidine contamination in the dyes.

o-DIANISIDINE AND o-DIANISIDINE-BASED DYES

Evidence of Carcinogenicity

Hadidian et al. administered o-dianisidine hydrochloride by gavage to rats for 1 year.(32) Tumors developed in the Zymbal's gland, skin, mammary gland, stomach, intestinal tract, and bladder. Most tumors developed after 8 months. The control animals had a relatively low spontaneous tumor rate except for interstitial cell tumors.

Saffiotti et al. and Sellakumar et al., working together, fed 0.1% or 1.0% o-dianisidine to two groups of 60 Syrian Golden hamsters of both sexes throughout their lifetime.(33,34) After 2 years, one tumor of the urinary bladder was found in a hamster fed at the 0.1% level. Forestomach papillomas developed in 57% of the 60 hamsters fed at the 1.0% level.(34) The spontaneous incidence of forestomach papillomas was 2% in the control group of 60 hamsters.[See Note 4].

Pliss administered o-dianisidine to rats by gavage for 13 months. (26,27) In the surviving animals, 3 of 18 developed tumors. None of the 50 control rats developed spontaneous tumors. IARC concluded that o-dianisidine was carcinogenic in rats after oral administration.(35)

Metabolism of o-Dianisidine-Based Dyes to o-Dianisidine

There is evidence that dogs, rats, and humans may metabolize some o-dianisidine-based dyes to the parent compound. As in the case of the o-tolidine-based dyes, a residual amount of the parent compound may be present in the dye.(19) Lynn et al. studied the metabolism of the o-dianisidine-based dyes, C.I. Direct Blue 1 and C.I. Direct Blue 15, in female mongrel dogs and rats.(19) Following the administration of the dyes, o-dianisidine was recovered in the urine of both species. The amount of o-dianisidine recovered in the urine exceeded that which could have been contributed by o-dianisidine contamination alone, according to the authors.

Genin studied the metabolism of two o-dianisidine based dyes, C.I. Direct Blue 15 and Direct Blue Photostable KU, in rats and found o-dianisidine was excreted in the urine.(20) In the same study, Genin reported that he found o-dianisidine in the urine of 3 of 22 workers who dried and ground two dianisidine-based dyes, C.I. Direct Blue 15 and Direct Blue Photostable KU. Boeniger reported finding o-dianisidine in the urine of a worker in a dye manufacturing plant. (10) This employee worked with o-dianisidine- based dyes and not with o-dianisidine itself. The o-dianisidine in the urine may have resulted from metabolism of the dyes or from contamination in the dyes.

o-Dianisidine is used as the starting material in the manufacture of the o-dianisidine-based dyes listed in Appendix IIB. It has been

Note 4: According to Saffiotti, 57% is the correct percentage of hamsters that developed forestomach papillomas, not 37% as given in the publication cited. Personal Communication, U. Saffiotti, 1979.

reported that some of these dyes may no longer contain the methoxy group characteristic of the o-dianisdine moiety as a major component in the dye due to chemical reactions with metals such as copper. (36) Based on structural considerations, it is unlikely that metalized o-dianisidine dyes would metabolize to o-dianisidine. However, the amount of residual o-dianisidine in these dyes is unknown at this time. The contribution of the metal to subsequent toxicity is also unknown at this time.

RECOMMENDATIONS

From the available evidence OSHA and NIOSH conclude that benzidine based dyes are potential human carcinogens. OSHA and NIOSH recommend that worker exposure to these dyes be reduced to the lowest feasible level. The available literature on dyes based on o-tolidine and o-dianisidine, while less extensive and definitive than that for benzidine-based dyes, suggests that these compounds and/or their contaminants may present a cancer risk to workers and should be handled with caution and exposure minimized. Workers should be informed of the potential of dyes based on benzidine, o-tolidine, and o-dianisidine to affect their health.

Several actions should be taken by employers, employees, and their physicians in order to protect workers from exposure to benzidine-, o-tolidine-, and o-diansidine-based dyes.

I. Employers should:

1. Substitute, wherever possible, other less toxic dyes for benzidine-based dyes. Although the literature is less definitive and less extensive in supporting the carcinogenicity of o-tolidine and o-dianisidine-based dyes, OSHA and NIOSH recommend, as a prudent public health measure, substitution of less toxic dyes wherever possible. Caution should be exercised in selecting replacements. Full consideration should be given to the potential toxic effects of the substitutes.

2. Establish, where substitution is not feasible, appropriate and feasible engineering controls for all these chemicals. Engineering controls may include the use of closed process systems, liquid metering systems, walk-in hoods, and specific local exhaust ventilation. Suitable collectors should be used to prevent ambient air contamination.

3. Ensure that good housekeeping procedures and industrial hygiene practices are used to keep the work environment free of accumulated dyes and to reduce the exposure of all workers to the dyes. These procedures include, in part, the use of dyes in the form of pellets, pastes, and liquids to reduce potential exposure to dusts.

4. Establish restricted areas (with appropriate warning signs) for activities that involve occupational exposure to these dyes. Access to these restricted areas should be limited to employees who have been properly informed of the potential hazards and of proper control measures.

5. Inform all employees working with these dyes, or mixtures containing them, of the possible adverse health effects that may result from exposure to them and of acceptable ways to reduce that exposure.

6. Provide all employees who may be exposed to these dyes with a copy of this Health Hazard Alert.

7. Place all employees with occupational exposure to these dyes under a medical monitoring program that includes a medical history and periodic physical examinations. Each examining physician should be provided with a copy of this Health Hazard Alert.

8. Provide washroom or shower facilities and change rooms for employees to remove residual chemical from themselves after leaving the work area where exposure occurs. Cleaning compounds that contain strong reducing agents, such as sodium hydrosulfite, should not be used for skin decontamination.

9. Monitor employee exposure to these chemicals routinely. Exposure surveys should be made to establish the extent of exposure and the effectiveness of controls. An analytical method for quantifying benzidine-based dyes in the presence of other azo type dyes and diazonium compounds has been recently developed by NIOSH. The details of this method are available from:

Publication Dissemination, Division of
Technical Services
National Institute for Occupational Safety
and Health
4676 Columbia Parkway
Cincinnati, Ohio 45226

The NIOSH Manual of Analytical Methods also may be helpful to those developing programs to monitor employee exposures. (37,38)

10. Provide and require personal protective clothing to be used as an interim measure while engineering controls are being installed. Whenever employees leave the area, their protective clothing should be placed in a suitably marked and closed container for disposal or laundering. Laundry personnel should be made aware of the potential hazard from handling contaminated clothing.

11. Provide respiratory protective devices. Table 2 contains acceptable respirators that may be used to reduce exposure.

II. Employees should:

1. Use the correct safety equipment and protective devices as provided by the employer.

2. Wash exposed areas of the body with soap and water upon leaving the restricted area. Cleaning compounds that contain strong reducing agents should not be used because benzidine or other harmful products could be formed on the skin.

3. Dispose of protective clothing in the manner prescribed by the employer.

4. Report signs or symptoms of health problems to your physician if you suspect that you may be exposed to these chemicals.

III. Physicians should:

1. Obtain occupational and exposure histories.

2. Obtain a medical history with special emphasis on complaints associated with the urinary tract and hepatic systems.

3. Perform a physical examination with emphasis on the renal and hepatic systems.

4. Obtain laboratory studies for liver and renal function and a urinalysis that includes microscopic examination of the sediment.

5. Advise the employee of the results of the medical examination and laboratory analyses.

Table 2

RESPIRATORS FOR USE WITH

BENZIDINE, o-TOLIDINE, and o-DIANISIDINE-BASED DYES

Maximum Use Concentration of Conditions of Use	Recommended Respirator
Routine Use	1. Half-mask powered air-purifying respirator equipped with high-efficiency filters.* Disposable air filters should be replaced after each 8 hours of use.
	2. Half-mask positive-pressure supplied air respirator.*
	3. Full facepiece powered air-purifying respirator equipped with high-efficiency filters. Disposable air filters should be replaced after each 8 hours of use.
	4. Positive-pressure supplied air respirator with full facepiece, hood or helmet.
Unknown Concentration or Emergency Entry	1. Full facepiece positive-pressure self-contained breathing apparatus.
	2. Full facepiece positive-pressure supplied air respirator with auxiliary self-contained air supply.
Fire Fighting	Full facepiece positive-pressure self-contained breathing apparatus.

* Full facepieces should be used whenever eye irritation is experienced.

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APPENDICES

Appendix I is a list of benzidine-based dyes reported to be commercially available in the United States. The list includes Colour Index number of the dyes, domestic production and import quantities, usage by industry, and estimated number of workers exposed.* Appendix II is a list of benzidine-, o-tolidine- and o-dianisidine-based dyes currently available in the United States including Colour Index number, generic names, commercial trade names, and manufacturers and distributors.** These appendices may not be complete. The field of dye chemistry is constantly changing and products are added and removed from the market continually. Further details concerning these dyes can be found in the Colour Index and the American Association of Textile Chemists and Colorist (AATCC) Buyers Guide. Estimates of total dyes usage by industry are: For the textile industry, 66% of all dyes used in the U.S.; for the paper and pulp industry, 17%; for the leather tanners industry, 10%; and for the aqueous ink and plastics industries, about 7%.

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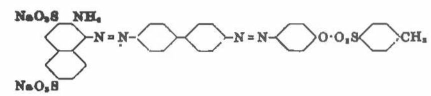
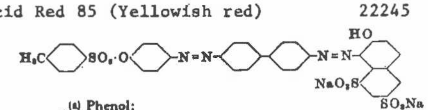
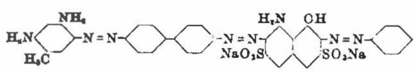
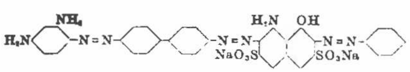
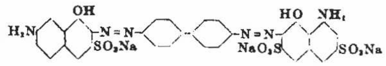
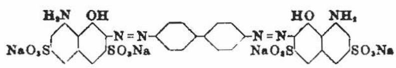
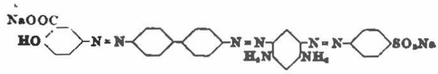
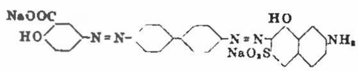
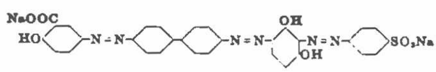
* Taken from Appendix III, Special Occupational Hazard Review of Benzidine-Based Dyes. NIOSH Report. DHEW (NIOSH) Publication No. 80-109, 1980.

** Derived from Table I (Corrected), Responses to Questions on Dyes, Submission to Interagency Testing Committee-Subcommittee to Review Dyes and Pigments by Dyes Environmental and Toxicology Organization, Scarsdale, NY, July, 1979.

APPENDIX I

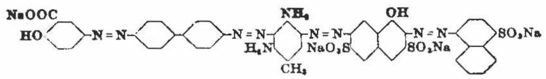
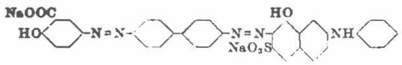
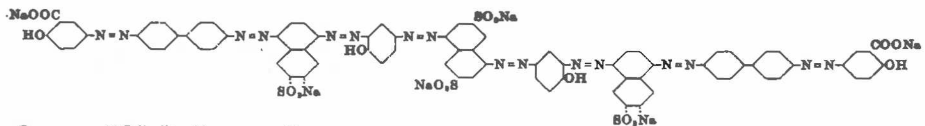
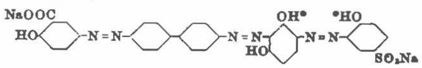
BENZIDINE-BASED DYES REPORTED TO BE COMMERICALLY AVAILABLE IN THE UNITED STATES*

Chemical Structure	Colour Index No.	Chemical Abstracts Service No.	Total Produced lb/y	Total Imported lb/y	Uses	Estimated No. of Workers Exposed**
C.I. Acid Orange 45 (Reddish orange)  Benzidine < 3-Amino-2,7-naphthalenedisulfonic acid; Phenol; *then esterify the hydroxy group with* p-*toluenesulfonyl chloride*	22195	2429-80-3	Not reported; less than 3 manufacturers	Not listed	Dyeing of cotton, silk, nylon, and leather; heavy metal salts used as pigments	Unknown
C.I. Acid Red 85 (Yellowish red)  Benzidine < (2) Phenol; (1) G acid *then esterify the phenol hydroxy group with* p-*toluenesulfonyl chloride* There are closely related dyes in which benzidine may be replaced by tolidine and other esterifying agents may be used. See C.I.23635 and C.I.24125	22245	3567-65-5	67,000(1975) 22,245(1978)	2,190(1976) 1,000(1978)	Dyeing of cotton, wool, silk, nylon, and viscose; Viqoureux printing	525
C.I. Direct Black 4 (Black)  Benzidine < (2) Toluene-2,4-diamine; (1) (*acid*) H acid (*alk.*) (2) ← Aniline Aqueous solution + HCl conc. — corinth ppt; NaOH conc. — greyish blue ppt.	30245	2429-83-6	26,444(1978)	Not listed	Dyeing of cotton, wool, silk, nylon, leather, and paper	Unknown
C.I. Direct Black 38 (Black)  Benzidine < (2) *m*-Phenylenediamine; (1) (*acid*) H acid (*alk.*) (2) ← Aniline	30235	1937-37-7 RTECS No. JM7170000	3,760,000(1976) 823,000(1978)	70,753(1976) 49,525(1977) 170,442(1978)	Dyeing of leather, plastics, cotton, wool, and silk; aqueous inks, biological stain; wood flour used as a resin filler, wood stain; typewriter ribbons	13,072

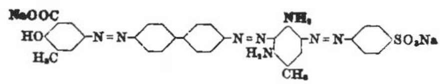
Chemical Structure	Colour Index No.	Chemical Abstracts Service No.
C.I. Direct Blue 2 (Dull Blue)  Benzidine ⟨ (2) (*alk.*) Gamma acid / (1) (*alk.*) H acid	22590	2429-73-4
C.I. Direct Blue 6 (Blue)  Benzidine ⇉ (*alk.*) H acid (2 mol.) Aqueous solution + HCl conc. — navy blue, ppt; + NaOH conc. — dark violet, ppt.	22610	2602-46-2 RTECS No. QJ6400000
C.I. Direct Brown 1 (Brown)  Benzidine ⟨ (1) Salicylic acid / (2) [m-Phenylenediamine (*acid*) ← Sulfanilic acid]	30045	2586-58-5
C.I. Direct Brown 2 (Reddish brown)  Benzidine ⟨ (1) Salicylic acid / (2) (*alk.*) Gamma acid	22311	2429-82-5
C.I. Direct Brown 6 (Brown)  Benzidine ⟨ (1) Salicylic acid / (2) Resorcinol (2) ← Sulfanilic acid This sequence of operations, which is that recorded for Congo Brown G, differs slightly from C.I. 1st Edition 598	30140	NA

[(CONTINUED)

Total Produced lb/y	Total Imported lb/y	Uses	Estimated No. of Workers Exposed**
218,435(1978)	38,478(1976) 30,755(1978)	Dyeing of cotton, leather, and paper	1,958
327,000(1976) 61,524(1978)	4,409(1978)	Dyeing of leather, cotton, silk, paper; aqueous writing inks, biological stains	832
Not listed	4,409(1978)	Dyeing of leather, paper, silk, nylon, wool and cotton	Unknown
125,000(1975) 27,725(1978)	18,739(1976) 2,205(1977)	Dyeing of leather, paper, silk, nylon, wool, and cotton; heavy metal salts used as pigments	106
8,563(1978)	Not listed	Dyeing of leather, paper, silk, wool, and cotton	Unknown

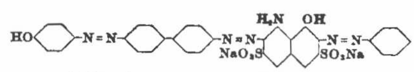
Chemical Structure	Colour Index No.	Chemical Abstracts Service No.	Total Produced lb/y	Total Imported lb/y	Uses	Estimated No. of Workers Exposed**
C.I. Direct Brown 31 (Reddish brown)  Benzidine (1) Salicylic acid (2) (Toluene-2,4-diamine (acid) ← *O*-Phenylsulfonyl 2R acid); *then hydrolyse the benzenesulfonic ester group* (2) ← Naphthionic acid (In some brands 2R acid is used instead of its *O*-phenylsulfonyl derivative* as in C.I.35650)	35660	2429-81-4	37,406(1978)	Not listed	Dyeing of leather and paper; heavy metal salts used as pigments; printing on cellulosics (concentrated dye only)	Unknown
C.I. Direct Brown 59 (Blackish brown)  Benzidine (1) Salicylic acid (2) (*alk.*) *N*-Phenyl Gamma acid	22345	NA	Not listed	"	Dyeing of cotton, wool, and silk; leather; occasional use on chrome and vegetable tannages	"
C.I. Direct Brown 74 (Brown)  [Benzidine (1) Salicylic acid (2) 1,6(and 1,7)-Cleve's acid](2 mol.) ⇉ (2) [Phenol (2 mol.) ⇇ 4,8-Diamino-2,6-naphthalenedisulfonic acid] HNO_3 conc. — dull red solution, turns yellow brown Aqueous solution + HCl conc. — brownish yellow to olive ppt; + NaOH conc. — orange brown	36300	NA	32,414(1978)	"	Dyeing of cotton, wool, silk, leather, chrome tannage (occasional)	"
C.I. Direct Brown 95 (Reddish brown) Copper complex derived from  Benzidine (1) Salicylic acid (2) [Copper complex formed at * from 2-Amino-1-phenol-4-sulfonic acid → Resorcinol] In Sirius Supra Brown BRLN 20% of the salicylic acid is replaced by 2,3-cresotic acid	30145	16071-86-6 'RTECS No. JM78780000	346,000(1975) 595,000(1976) 75,953(1978)	8,205(1976) 15,962(1977) 5,512(1978)	Dyeing of cotton, wool, silk paper, plastics, and leather; heavy metal salts used as pigments	714

Chemical Structure	Colour Index No.	Chemical Abstracts Service No.
C.I. Direct Brown 111 (Reddish brown) Structure Unknown	No C.I. No.	NA
C.I. Direct Brown 154 (Brown)	30120	6360-54-9



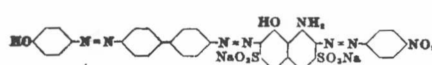
Benzidine< 2,3-Cresotic acid / [Toluene-2,4-diamine ← Sulfanilic acid]

C.I. Direct Green 1 (Dull green)	30280	3626-28-6



Benzidine< (2) Phenol / (1) (acid) H acid (alk.) (2) ← Aniline

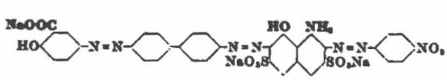
C.I. Direct Green 6 (Dull green)	30295	4335-09-5



Benzidine< (2) Phenol / (1) (alk.) [H-acid (acid) ← p-Nitroaniline]

Aqueous solution + HCl conc. — dull bluish green ppt; + H_2SO_4 (10%) — bluer; + NaOH conc. — dark green to olive

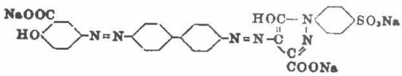
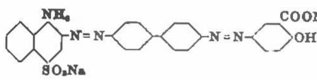
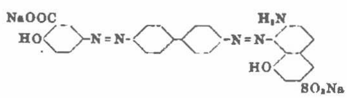
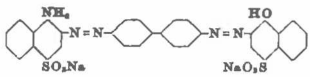
C.I. Direct Green 8 (Dull green)	30315	5422-17-3



Benzidine< (1) Salicylic acid / (2) (alk.) [H acid (acid) ← p-Nitroaniline]

(CONTINUED)

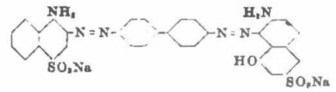
Total Produced lb/y	Total Imported lb/y	Uses	Estimated No. of Workers Exposed**
Not listed	Not listed	Dyeing of cotton and leather; chrome tannage (occasional)	Unknown
63,816(1978)	"	Dyeing of cotton, wool, silk, leather, and paper; direct printing on cellulosic weave and silk fabrics	322
57,000(1974) 12,666(1978)	"	Dyeing of cotton, wool, silk, nylon, leather, and paper; aqueous inks; direct printing on cellulosic, silk, and nylon fabrics	1,850
143,000(1974) 109,076(1978)	4,659(1978)	Dyeing of cotton, wool, silk, and nylon; aqueous inks, pigments, leather, paper, and soap; direct printing on nylon	1,095
Not reported; less than 3 manufacturers	250(1977)	Dyeing of cotton, wool, silk, nylon, leather, and paper	Unknown

Chemical Structure	Colour Index No.	Chemical Abstracts Service No.
C.I. Direct Orange 1 (Yellowish orange)***	22370	6459-87-6
 Benzidine ↗ Salicylic acid ↘ 3-Carboxy-1-(*p*-sulfophenyl)-5-pyrazolone		
C.I. Direct Orange 8 (Reddish orange)	22130	2429-79-0
 Benzidine ↗ (2) Naphthionic acid ↘ (1) Salicylic acid *In some brands part of the salicylic acid is replaced by 2,3-cresotic acid* (C.I.22140) *and part of the naphthionic acid by other aminonaphthalenesulfonic acids* (C.I.22165)		
C.I. Direct Red 1 (Bluish red)	22310	2429-84-7
 Benzidine ↗ (1) Salicylic acid ↘ (2) (*acid*) Gamma acid		
C.I. Direct Red 10 (Bordeaux)	22145	2429-70-1
 Benzidine ↗ (1) Naphthionic acid ↘ (2) Nevile and Winther's acid		

(CONTINUED)

Total Produced lb/y	Total Imported lb/y	Uses	Estimated No. of Workers Exposed**
Not reported; less than 3 manufacturers	Not listed	Dyeing of cotton, wool, silk, nylon, paper, and leather direct printing on cellulosics and nylon	Unknown
86,000(1976) 27,208(1978)	4,066(1976)	Dyeing of cotton, wool, silk, nylon, and paper	"
132,000(1975) 26,370(1978)	4,409(1977)	Dyeing of cotton, wool, silk, nylon, paper, and leather	55,508
Not reported; less than 3 manufacturers	100(1975)	Dyeing of cotton, wool, silk, and leather; biological stain	Unknown

Chemical Structure	Colour Index No.	Chemical Abstracts Service No.
C.I. Direct Red 13 (Bordeaux)	22155	1937-35-5

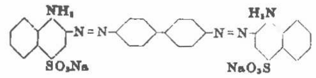


Benzidine → (1) Naphthionic acid; (2) (*acid*) Gamma acid

(In *Diamine Bordeaux N* (By) part of the Gamma acid was replaced by J acid)

Chemical Structure	Colour Index No.	Chemical Abstracts Service No.
C.I. Direct Red 28 (Yellowish red)	22120	573058-0 RTECS No. QK1400000

Classical name Congo Red



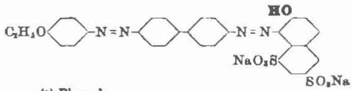
Benzidine ⇉ Naphthionic acid (2 mol.)

Soluble in water (yellowish red) and ethanol (orange); very slightly soluble in acetone

H_2SO_4 conc. — deep blue; on dilution — paler blue, blue ppt.

Aqueous solution + **HCl conc. — reddish blue** ppt; + Acetic **acid — bluish violet, then reddish blue ppt.**; + NaOH **conc. — yellower**

Chemical Structure	Colour Index No.	Chemical Abstracts Service No.
C.I. Direct Red 37 (Red)	22240	3530-19-6

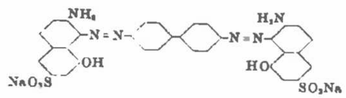
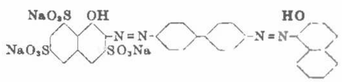
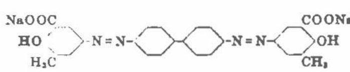


Benzidine → (2) Phenol; (1) G acid

then ethylate the phenol hydroxy group by heating under pressure with ethyl chloride in aqueous ethanol solution in the presence of sodium carbonate

(CONTINUED)

Total Produced lb/y	Total Imported lb/y	Uses	Estimated No. of Workers Exposed**
Not reported; less than 3 manufacturers	Not listed	Dyeing of cotton, wool, nylon, paper, and leather (chrome tannage); printing of cellulosics	1,640
37,327(1978)	11,000(1974) 33,069(1978)	Dyeing of cotton, wool, silk, and paper; biological stain and indicator; (first synthetic direct cellulose dye)	523
63,000(1975)	Not listed	Dyeing of cotton, wool, silk, leather and paper; direct and discharge printing of cellulosics and nylon	1,052

Chemical Structure	Colour Index No.	Chemical Abstracts Service No.	Total Produced lb/y	Total Imported lb/y	Uses	Estimated No. of Workers Exposed**
C.I. Direct Violet 1 (Violet)  Benzidine ⇉ (*acid*) Gamma acid (2 mol.)	22570	2586-60-9	Not reported; less than 3 manufacturers	Not listed	Dyeing of cotton, wool, silk, leather, and paper; biological stain	Unknown
C.I. Direct Violet 22 (Bluish violet)  Benzidine → 1-Naphthol-3,6,8-trisulfonic acid → 2-Naphthol	22480	6426-67-1	" manufacturers	"	Dyeing of cotton, wool, silk, nylon, leather	"
C.I. Direct Yellow 20 (Yellow)  Benzidine ⇉ 2,3-Cresotic acid (2 mol.) Aqueous solution + HCl conc. — brownish yellow, ppt; + NaOH conc. — reddish yellow, ppt.	22410	6426-62-6	Imported only	3,900(1977)	Dyeing of cotton, silk, wool, nylon, leather	"
Resin Fast Black WP	No C.I.#	NA	84,620(1978)	Not listed	Dyeing of textiles, especially those subsequently finished with resins	"

*This table lists the benzidine-based dyes that were reported as being commerically available by DETO [39] and reported as produced or imported by the US International Trade Commission (ITC) [40,41] or those to which potential exposure was found [42]. If less than three manufacturers make a dye, ITC does not publish the production figures.

**A discussion of limitations of the estimation of worker exposure is contained in reference [42].

***This dye may also be synthesized with cresotic acid in place of salicylic acid. The Colour Index designates both dyes as Direct Orange 1.

APPENDIX II A

DYES DERIVED FROM BENZIDINE

Direct Black 4 : 30245**	Amidine Black RBN (JC)* Direct Black RX 125% (FAB) Direct Black RW Ex.Conc.(CKC)
Direct Black 38: 30235	Amidine Black GA 200% (JC) Diazol Black JXA Double (Fran) Direct Black E 200% (FAB) Direct Black E Ex. Conc. New (CKC) Direct Black BHX (CKC) Direct Black GAC Conc. 200% (BUC) Direct Black GX 200% (FAB) Elcomine Direct Black CP Conc. (L&R) Elcomine Direct Black GXP 200% (L&R) Orcomine Direct Black GX 200% (ORC) Synodirect Black GAC (SSS)
Direct Blue 2: 22590	Amidine Diazo Black BHSW Conc. (JC) Diazo Black BH (FAB) Diazo Black BHA (Fran) Elcomine Black BH (L&R) Elcomine Navy Blue Btt (L&R) Orco Diazo Black BH 125% (ORC)
Direct Blue 6: 22610	Amidine Blue 2B Conc. (JC) Direct Blue 2B 250% (FAB) Direct Blue 2B Conc. (CKC) Direct Fast Blue 2B Conc. (FAB) Elcomine Blue 2B 250% (L&R) Synodirect Blue 2B 100% (SSS)
Direct Brown 1A: 30110	Amidine Brown 3GC 250% (JC) Elcomine Brown D3G Conc. (L&R)
Direct Brown 2: 22311	Amidine Brown M Conc. New (JC) Direct Brown M (CKC) Direct Brown M (FAB) Elcomine Brown M Conc. (L&R)

* See page A-21 for full name of manufacturers and/or importers corresponding to code letters in parentheses.

** Colour Index numbers

Direct Brown 6:	Direct Brown 2R (FAB)
30140	
Direct Brown 31:	Direct Brown B 125% (FAB)
	Direct Brown BCW (CKC, FAB)
35660	Elcofast Brown B. Conc. (L&R)
	Solamidine B (JC)
Direct Brown 59:	Amidine Brown DMB (JC)
22349	
Direct Brown 74:	Direct Catechine 3G (FAB)
	Elcofast Catechine 3G (L&R)
36300	
Direct Brown 95:	Chrome Leather Brown (CKC)
	Diazol Light Brown BRN Ultra Conc. (Fran)
	Direct Brown BRL (FAB)
30145	Elcomine Brown BRLL (L&R)
	Intralite Brown BRLL Conc. (CKC)
	Synodirect Brown BRL 100% (SSS)
Direct Brown 154:	Direct Brown 3GN (FAB)
	Direct Brown CMD (CKC)
30120	Elcomine Brown 3GNP (L&R)
Direct Green 1:	Amidine Dark Green N (JC)
	Chrome Leather Dark Green S Conc. (CKC)
30280	Direct Green WS (FAB)
	Elcomine Green WT (L&R)
	Orcomine Dark Green WS (ORC)
Direct Green 6:	Amidine Green 2BN (JC)
	Amidine Green M Special (JC)
30295	Direct Brilliant Green CBM Ex.Conc.(CKC)
	Direct Green BX (FAB)
	Direct Green MT 150% (FAB)
	Elcomine Green MT 150% (L&R)
	Orcomine Green BX (ORC)
Direct Green 8:	Amidine Green GX (JC)
30315	

Direct Orange 1: 22370, 22375 and 22430	Orcolitefast Orange GLZ (ORC)
Direct Orange 8: 22130	Direct Fast Orange R (FAB) Direct Paper Orange R Conc. (FAB) Direct Orange R (CKC) Elcomine Orange RP Conc. (L&R) Paper Orange R (CKC) Synodirect Orange Y 100% (SSS)
Direct Red 1: 22310	Amidine Fast Red F New (JC) Congo Red F (CKC) Direct Fast Red F (FAB) Elcofast Red FD (L&R) Orcomine Red F (ORC)
Direct Red 28: 22120	Congo Red (CKC) Direct Congo Red 4B (FAB) Elcomine Congo Red (L&R) Orcomine Congo Red (ORC) Synodirect Red 4B 100% (SSS)
Direct Red 37: 22240	Amidine Fast Scarlet BN Conc. (JC) Direct Fast Scarlet B (FAB) Elcomine Scarlet B (L&R) Orcomine Scarlet B (ORC)
Direct Violet 1: 22570	Amidine Violet N (JC) Elcomine Violet 3R Conc. (L&R)
Direct Violet 22: 22480	Elcomine Violet BW 200% (L&R)
Acid Red 85: 22245	Intrazone Fast Red GRG (CKC) Milling Red 2J (Fran) Milling Scarlet G (FAB) Nylon Fast Scarlet PG (FAB) Supernylite Scarlet G (CKC)

APPENDIX II B

DYES DERIVED FROM O-DIANISIDINE

Direct Black 91: 30400	Cuprotix Black C-RL (S) Cuprophenyl Black RL 200% (CGY) Intramet Black GM (CKC)
Direct Black 114: ________	Cuprophenyl Black BWL (CGY)
Direct Blue 1: 24410	Amanil Sky Blue 6B (AC) Amanil Sky Blue FF (AC) Atlantic Sky Blue 6B Conc.(ATL) Atlantic Sky Blue FF Ex.Conc. (ATL) Calcomine Sky Blue 6 BX Conc. (ACY) Diazol Blue 6BA Conc. (Fran) Diphenyl Brilliant Blue FF Supra (CGY) Direct Brilliant Sky Blue 6B Ex. Conc. (CKC) Direct Sky Blue 6B (BUC) Direct Sky Blue 6B Conc. (FAB) Direct Sky Blue 6B Ex. 200% (ATL) Direct Sky Blue 6B Ex. Conc. 300% (ATL) Direct Sky Blue 6BHF (HSH) Direct Sky Blue FF Ex. 200%, 300% (ATL) Elcomine Sky Blue 6B Ex. 200% (L&R) Pergasol Blue GA Conc. (CGY) Phenamine Brilliant Blue 6B Conc. (BAS) Pyrazol Sky Blue FF (S)
Direct Blue 8: 24140	Atlantic Azurine G Conc. (ATL) Direct Azurine G (ATL) Direct Azurilne G Conc. (ATL)
Direct Blue 15: _______	Amanil Sky Blue M Liquid (AC) Amidine Sky Blue 5B Ex. (JC) Atlantic Sky Blue A Ex. Conc. (ATL) Blue M Liquid (ATL) Cartasol Blue 2GF (S) Direct Sky Blue A Supra Conc. 125% (ATL) Intrabond Liquid Sky Blue M (CKC) Paper Sky Blue S Liquid 35 (V) Pontamine Sky Blue M Liquid (DUP)
Direct Blue 22: 24280	Atlantic Direct Blue RW 100% (ATL) Direct Blue RW Conc. 200% (ATL)

Direct Yellow 68:	Cuprophenyl Yellow RL Extra (CGY) Intramet Yellow RL (CKC)
________	
Direct Violet 93:	Cuprophenyl Violet 3RL (CGY)
_________	
Azoic Blue Composition 2: ________	Atlantic Printing Blue D-BC Pdr. (ATL) Atlantic Printing Blue D Pdr. (ATL) Neutrazoic Blue AS Pdr. (ATL) Neutrazoic Blue D (ATL)
Azoic Blue Composition 3: _________	Atlantic Printing Blue GBl Pdr. (ATL) Neutrazoic Blue GB Pdr.(ATL) Neutrazoic Blue GN Pdr. (ATL)
Azoic Black Composition 4: ________	Atlantic Printing Black 3G Pdr. (ATL)
Azoic Diazo Component 48: 37235	Atlantic Stable Blue B Pdr. (ATL) Azoene Fast Blue B Salt (ALL) Fast Blue B-ND Salt (BUC) Fast Blue B Salt (ATL, BUC, PCW, V) Fast Blue B-ND Base (ATL) Stable Blue B Base (ATL)
Azoic Coupling Component 3: 37575	Naphthol AS-BR (ATL) Naphthol AS-BR,AS-BR Soln. (BUC, PCW) Naphthol AS-BR 20% Soln. (BUC)

Dyes Derived from o-Diansidine Without Colour Index Generic Names

Atlantic Direct Blue 2BNB (ATL)
Atlantic Printing Black 2B Pdr. (ATL)
Atlantic Printing Black FOR Pdr. (ATL)
Neutrazoic Black 2B Pdr. (ATL)
Neutrazoic Black FOR Pdr. (ATL)
Neutrazoic Black GF 167% Pdr. (ATL)
Neutrazoic Black JN Pdr. (ATL)
Padazoic Black GLL Pdr. (ATL)
Padazoic Black RLL Pdr. (ATL)
Padazoic Black 2G 150% Pdr.(ATL)
Padazoic Blue GP Pdr. (ATL)
Padazoic Denim Indigo Blue G Pdr.(ATL)
Padazoic Navy Blue WS EX Pdr. (ATL)
Pontamine Blue WE Liq. (DUP)

Padazoic Brilliant Indigo 3B Pdr. (ATL)
Padazoic Denim Indigo Pdr. (ATL)

Atlantic Printing Brown GGN Pdr. (ATL)
Atlantic Printing Brown BR Pdr. (ATL)
Neutrazoic Brown BR Pdr.(ATL)
Padazoic Farmer Brown Pdr.(ATL)

Metalized o-Dianisidine Based Dyes*

Direct Blue 76*:	Amafast Blue 16BLL (AC)
	Atlantic Resin Fast Blue 16BLL Conc.(ATL)
24411	Atlantic Resin Fast Blue LLGG (ATL)
	Diazol Light Blue 7JL U.C. (Fran)
	Fastusol Brilliant Blue L2GU (BAS)
	Resin Fast Blue 16BLL (FAB)
	Superlitefast Brilliant Blue 16BLL (CKC)

* Formation involves a metalizing process. The substance does not contain methoxy groups characteristic of the o-dianisidine moiety as major component of the dye. Minor amounts of residual o-dianisidine related substances are unknown at this time.

Direct Blue 80*:	Atlantic Resin Fast Blue RLX (ATL) Atlantic Resin Fast Blue 2RLL (ATL) Elcofast Blue 2RL (L&R) Fastusol Blue LRRU (BAS) Intralite Blue 2RLL (CKC) Pergasol Blue 4RAL (CGY) Pyrazol Fast Blue RUL (S) Resin Fast Blue 7RLL (FAB) Sirius Supra Blue 2RL (V) Solophenyl Blue ZRL (CGY) Superlitefast Blue RL (CKC) Superlitefast Blue RLE (CKC)
Direct Blue 80(s)*:	Intralite Blue NBLL (CKC) Solophenyl Blue RBL (CGY)
Direct Blue 90*:	Pyrazol Fast Blue FGL (S)
Direct Blue 98*: 23155	Atlantic Resin Fast Blue LLU (ATL) Atlantic Resin Fast Blue LLU 200% (AIL) Atlantic Resin Fast Blue LLUG (ATL) Diazol Blue 3JLNA (Fran) Direct Fast Navy BRN (HSH) Fastusol Blue LR (BAS) Intralite Brilliant Blue L (CKC) Pyrazol Fast Blue LUL (S) Resin Fast Navy WRA (FAB) Sirius Supra Blue BRL (V)
Direct Blue 100*:	Resin Fast Blue 3GLL (FAB) Superlitefast GL (CKC)
Direct Blue 151*: 24175	Diazol Fast Blue MP, MP Conc. (ATL) Direct Blue R 100%, R. Conc. (ATL) Elcofast Diazo Blue B Conc. (L&R)
Direct Blue 156*:	Cupropheny1 Navy Blue BL (CGY) Intramet Navy Blue RL (CKC)

Direct Blue 160*:	Cuprodiasol Light Navy RL (Fran) Cuprofix Navy C-GRL (S) Cuprophenyl Navy Blue RL (CGY) Intramet Navy Blue RII Conc. 200% (CKC)
Direct Blue 191 (s)*:	Resin Fast Blue 8GLN (FAB) Superlitefast Blue 8GLN (CKC)
Direct Blue 218*: 24401	Amafast Blue 3GAV Conc. (AC) Amafast Bond Blue 10GLP Conc.,10GLP Liq. (AC) Bond Blue B (ATL) Carta Blue VP (S) Elcofast Bond Blue (L&R) Fastusol Blue 9GLP Liq.(BAS) Paper Blue 3 GAP (FAB) Pergasol Blue 8GLP Liq. (CGY) Pontamine Bond Blue B Liq. (DUP) Pontamine Fast Blue 7GUN (DUP) Pyrazol Fast Sky Blue 7GLN (S) Resin Fast Blue 3 GAV (FAB) Sirius Supra Blue 5G (V) Solophenyl Blue 8GL, 8GLP Liq. (CGY) Superlitefast Blue WB (CKC) Superlitefast Blue 8GUL (CKC) Superlitefast Blue 3GLST (CKC)
Direct Blue 218/224(s)*:	Intrabond Liquid Blue 8GLL (CKC) Intralite Blue 8GLL (CKC)
Direct Blue 224*:	Atlantic Resin Fast Blue 7GUL (ATL)
Direct Brown 200*:	Lumicrease Dark Brown 3LB (S)

Metalized o-Dianisidine Based Dyes Without Colour Index Generic Names*

Atlantic Resin Fast Blue ARL (ATL)
Atlantic Resin Fast Blue BFL (ATL)
Atlantic Resin Fast Blue BLA 150% (ATL)
Atlantic Resin Fast Blue BLC (ATL)
Atlantic Resin Fast Blue BRN (ATL)
Atlantic Resin Fast Blue 8BGI 200%(ATL)
Atlantic Resin Fast Blue 3GLL (ATL)
Atlantic Resin Fast Blue 5GLL (ATL)
Atlantic Resin Fast Blue 8GLN (ATL)
Atlantic Resin Fast Blue LBGL (ATL)
Atlantic Resin Fast Blue 6GKS (ATL)
Atlantic Resin Fast Blue 8GUM (ATL)
Atlantic Resin Fast Blue 9GLR (ATL)
Atlantic Resin Fast Blue UGLL (ATL)
Atlantic Resin Fast Blue FFBL (ATL)
Atlantic Resin Fast Blue GUL (ATL)

Atlantic Resin Fast Grey LVL (ATL)
Superlitefast Grey LVL (CKC)

Superlitefast Rubine WLKS (CKC)

APPENDIX II C

DYES DERIVED FROM o-TOLIDINE

Acid Red 114: 23635	Amacid Milling Red PRS (AC) Atanyl Red RS (ATL) Erionyl Red RS, RS 125% (CGY) Intrazone Red BR (CKC) Levanol Fast Red GG New (V) Milling Red SWB (ATL) Milling Red SWB Conc. (FAB) Nylon Fast Red RM (FAB) Nylosan Red F-RS (S) Orcoacid Milling Red RS 125% (ORC) Polar Red RS Conc. 125% (CGY) Telon Fast Red GG New (V)
Acid Red 167: ———	Nylosan Red F-BR (S) Milling Red B (ATL) Polar Red B (CGY)
Acid Black 209: ———	Sella Fast Black FC (CGY)
Azoic Coupling Component 5: 37610	Naphthol ASG, ASG 20% Soln. (BUC) Naphthol AS-G (ATL, PCW) Naphthol AS-G Soln. (PCW)
Azoic Yellow Composition 1: 37610 & 37090	Atlantic Printing Yellow GN Dbl. Soln.(ATL) Atlantic Printing Yellow GS DBl. Soln., GS Pdr.(ATL) Azogen Yellow GS (ALL) Neutrazoic Yellow GS, GS Pdr. (ATL)
Azoic Yellow Composition 2: 37610 & 37120	Atlantic Printiing Yellow 2G Pdr. (ATL) Azogen Yellow GG Soln. (ALL) Azogen Yellow GN (ALL) Neutrazoic Yellow 2G, 2G Pdr. (ATL)
Azoic Yellow Composition 3: 37610+37558 & 37090	Neutrazoic Golden Yellow R, R Pdr.(ATL)
Azoic Orange Composition 3: 37558 & 37010	Atlantic Printing Orange R, R Pdr. R. Dbl. Soln (ATL)

Direct Blue 14:	Carta Blue 3B (S)
	Chrome Leather Blue 3B (CKC)
23850	Diphenyl Blue 3B Conc. (CGY)
	Direct Blue 3B Conc. (CKC)
	Paper Blue 1 (CKC)
	Pergasol Blue 3B Conc. (CGY)
Direct Blue 25:	Diazol Pure Blue BRA (Fran)
	Diphenyl Brilliant Blue 5B (CGY)
23790	Direct Brilliant Blue 5BC Conc.(CGY,CKC)
	Direct New Blue 5B, 5B Conc.(ATL)
	Pergasol Brilliant Blue 5B (CGY)
	Pyrazol New Blue (S)
Direct Blue 26:	Direct Chrome Blue Black B Ex. Conc.(ATL)
31930	
Direct Orange 6:	Amidine Orange GG (JC)
	Direct Fast Orange Y 125% (ATL)
23365 or 23375	
Direct Red 2:	Amanil Purpurine 4B Conc. (AC)
	Benzopurpurine 4B Ex. Conc.,4B Special (AIL)
23500	Cotton Red 4BS Conc. (CKC)
	Diphenyl Red 4BS Supra (CGY)
	Direct Purpurine 4B (FAB)
	Elcomine Benzopurpurine (L&R)
	Paper Red 4BS Conc. (CKC)
	Pergasol Red 4BS Conc. (CGY)
Direct Red 39:	Amidine Scarlet 3B (JC)
	Atlantic Scarlet 3B (ATL)
23630	Carta Red 3B (S)
	Direct Fast Red 3B (CKC)
	Elcomine Scarlet 3B (L&R)
	Orcomine Scarlet 3B (ORC)
	Pyrazol Red 3B (S)
Direct Brown 230:	Direct Fast Brown BR-NB Conc. (AIL)
	Direct Fast Brown BRLT (ATL)
———	
Direct Yellow 95:	Cuprophenyl Yellow 3GL (CGY)
———	

Dyes Derived from o-Tolidine Without Colour Index Generic Names:

Atanyl Red NJ (ATL)
Diphenyl Green BBN (CGY)
Pyrazol Dark Green 3B (S)

Direct Fast Brown BCW-NB (ATL)
Direct Fast Brown BP-NB Conc. (ATL)
Direct Brown GG-NB (ATL)
Direct Brown US-NB (ATL)

Milling Red G-NB (ATL)
Padazoic Yellow G Pdr. (ATL)
Padazoic Golden Yellow RLL Pdr. (ATL)

Padazoic Orange GR Pdr. (ATL)

Penetrating Black AM-NB (CKC)

Sandolan Red N-3B (S)

CODE LETTERS OF MANUFACTURERS, IMPORTERS, AND DISTRIBUTORS

AC	American Color and Chemical Corporation
ACY	American Cyanamid Company
ALL	Alliance Chemical, Inc.
ATL	Atlantic Chemical Corporation
BAS	B.A.S.F. Wyandotte Corp.
BDO	Benzenoid Organics, Inc.
BUC	Blackman-Uhler, Chemical Division of Synalloy Corp.
CGY	Ciba-Geigy Corporation
CKC	Crompton and Knowles Corporation
DUP	E.I. DuPont De Nemours and Co., Inc.
FAB	Fabricolor Inc.
Fran	Francolor-subsidiary of Ugine Kuhlmann Co. (Importer/Distributor)
HSH	Harshaw Chemical Company
ICI	ICI United States
JC	John Campbell and Company (Importer/Distributor)
L&R	L&R International Dyestuffs Corp. (Importer/Distributor) (Formerly L&R Dyestuffs Corp.)
ORC	Organic Chemical Corporation (Importer/Distributor)
PCW	Pfister Chemical Ind.
PDC	Berncolors-Poughkeepsie, Inc.
S	Sandoz Colors and Chemicals
SSS	Sidney Springer Company (Importer/Distributor)
V	Verona Dyestuff Division, Mobay Chemical Corp.

NIOSH

MINI-ALERT

FEBRUARY 1984

Request for Assistance in Controlling Carbon Monoxide Hazard in Aircraft Refueling Operations

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

DHHS (NIOSH) Publication No. 84-106

REQUEST FOR ASSISTANCE IN CONTROLLING CARBON MONOXIDE HAZARD IN AIRCRAFT REFUELING OPERATIONS

Investigators from the National Institute for Occupational Safety and Health (NIOSH) conducted an evaluation of the occupational health hazards to workers who fuel jet aircraft. During the investigation, we learned that two workers had died in or near their refueling vehicles. Although carbon monoxide (CO) poisoning was not suspected at the time of the deaths, a combination of the unusual location of the engine exhaust (under the front bumper), the deterioration of rubber seals (boots) around the gear shift lever and the pedals, and the fact that the workers spend a considerable amount of time sitting in idling vehicles (especially during poor weather), led us to measure CO levels in the truck cabs. Dangerous concentrations of CO were found. The company involved instituted maintenance procedures and work practice rules requiring that the windows be kept open whenever the truck is occupied. However, recent spot checks suggest that many operators of airport refueling services are unaware of the risk, and therefore have not taken precautions to prevent dangerous concentrations of CO.

Carbon monoxide is a colorless, odorless gas which limits the ability of the blood to carry oxygen to the tissues. Symptoms of acute CO poisoning include headaches, rapid breathing, nausea, weakness, dizziness, confusion, hallucinations, and discoloration of the lips or nail beds. If the exposure level is high, loss of consciousness may occur without other symptoms. Death may result from depression of the functions of the brain, or if there is underlying coronary artery disease, from heart attack. Because CO remains in the blood for several days, there may be a gradual increase in body levels of CO over the course of a work week. Effects of chronic exposure are not completely known.

The combination of methods used to control CO exposure may vary from one location to another, and care must be taken to assure that the principles and laws of fire safety are not violated; some recommendations by NIOSH for controlling dangers of CO are listed below.

February 14, 1984

1. To minimize generation of CO, trucks should be converted to electric or diesel power. While generating less CO, the stronger odor of diesel exhaust also provides better warning properties than does the odor of gasoline exhaust.

2. Refueling trucks should be maintained so that entry of CO from beneath the cab is prevented. Rubber boots around pedals and levers should be intact, with tight fittings; grommets in holes through the firewall should fit snugly; rust holes in the floor pans or elsewhere should be closed; heater and fresh air intakes should be remote from the exhaust discharge; and exhaust systems should be checked regularly and tightened or replaced whenever leaks are suspected.

3. Engines should be well-tuned since proper fuel-to-air ratios will reduce the amount of CO produced.

4. There should be installed in the cab a continuous CO monitor with alarm to warn the operator before the concentration of CO becomes dangerous.

5. Workers should be provided access to waiting areas, which are as comfortable as the truck cabs; they should be required to vacate the cabs when not engaged in operating the vehicle.

6. Workers engaged in fueling operations should be encouraged to refrain from smoking because smoking elevates blood levels of CO enough to reduce margins of safety.

7. Interim work rules requiring that windows be kept open whenever the cab is occupied, and that vehicles be parked with the exhaust downwind from the air intake, while prudent, cannot be relied upon as long-term solutions. Under some circumstances, for example, CO concentrations could be higher with windows open, and positioning of the truck may be restricted by aircraft parking arrangements. Wiring the ventilation fan to operate whenever the engine is running, will usually build a positive pressure in a closed cab and minimize seepage-in of CO; however, in some circumstances such an arrangement might actually draw CO into the vehicle.

We are requesting the assistance of airport managers and editors of appropriate trade journals in bringing this information to the attention of fueling service operators. Oil companies may, through their routine inspection services provided to operators, be especially effective in controlling the risk.

Suggestions, requests for information on control practices, or questions related to this announcement, should be directed to the Division of Standards Development and Technology Transfer, National Institute for Occupational Safety and Health, 4676 Columbia Parkway, Cincinnati, Ohio 45226, telephone (513) 684-8302.

We greatly appreciate your assistance.

J. Donald Millar, M.D., D.T.P.H. (Lond.)
Assistant Surgeon General
Director, National Institute for
Occupational Safety and Health
Centers for Disease Control

NIOSH

ALERT

DECEMBER 1984

Request for Assistance in Preventing Electrocutions of Workers in Fast Food Restaurants

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

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DHHS (NIOSH) Publication No. 85-104

Additional copies of this Alert are available from:

Publications Dissemination, DSDTT
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, Ohio 45226
(513) 841-4287

REQUEST FOR ASSISTANCE IN PREVENTING ELECTROCUTIONS OF WORKERS IN FAST FOOD RESTAURANTS

BACKGROUND

On June 30, 1984, an 18-year-old male worker in a fast food restaurant died by electrocution on the job. The worker, who had 15 months' work experience at this restaurant, was electrocuted while kneeling to insert the plug of a portable electric toaster into a 110-120V/20 amp outlet on a floor which had recently been damp-mopped. The victim was found convulsing. He had one hand on the plug and the other on the receptacle box. Another worker who attempted to "take the pulse" of the victim received an electrical shock but was not injured.

When the assistant manager saw what was happening, he went to the breaker box to shut off the current but was unable to locate the appropriate breaker. The emergency rescue squad was called, and before they arrived, the proper circuit breaker was located and thrown. By that time, the victim had been in contact with the electricity for three to eight minutes. Attempts at cardiopulmonary resuscitation (CPR) by fellow workers and members of the emergency rescue squad were unsuccessful; the victim was pronounced dead on arrival at a nearby hospital.

The specific events that resulted in this electrocution could not be defined with absolute precision. However, investigators from NIOSH concluded that while the victim was inserting the plug of the toaster into the receptacle with his right hand and holding open the grounded metal receptacle cover with his left hand, the index finger of his right hand touched an energized prong of the plug and he received an electrical shock across the chest.

December 1984

RECOMMENDATIONS BY NIOSH

Because one-tenth (0.1) amp of electricity flowing through the human body for two seconds can cause death, any active electrical circuit can pose a potentially lethal hazard.

Electrical hazards in the kitchens of commercial restaurants are of particular concern because of the variety of electrical appliances in use. However, safeguards and safe work practices can eliminate most of these hazards. NIOSH recommends that:

1. Ground fault circuit interrupters (GFCI's) of the breaker or receptacle type be installed in situations where electricity and wetness coexist. GFCI's will interrupt the electrical circuit before current sufficient to cause death or serious injury has passed through a body. GFCI's are inexpensive ($50.00-$85.00 for breaker type, $25.00-$45.00 for receptacle type) and a qualified electrician can install them in existing electrical circuits with relative ease;

2. Exposed receptacle boxes be made of nonconductive material so that contact with the box will not constitute "a ground";

3. Plugs and receptacles be designed to prevent energization until insertion is complete;

4. All circuit breaker or fuse boxes bear a label for each circuit breaker or fuse which clearly identifies its corresponding outlets and fixtures. Also, breaker switches should not be used for on-off switches;

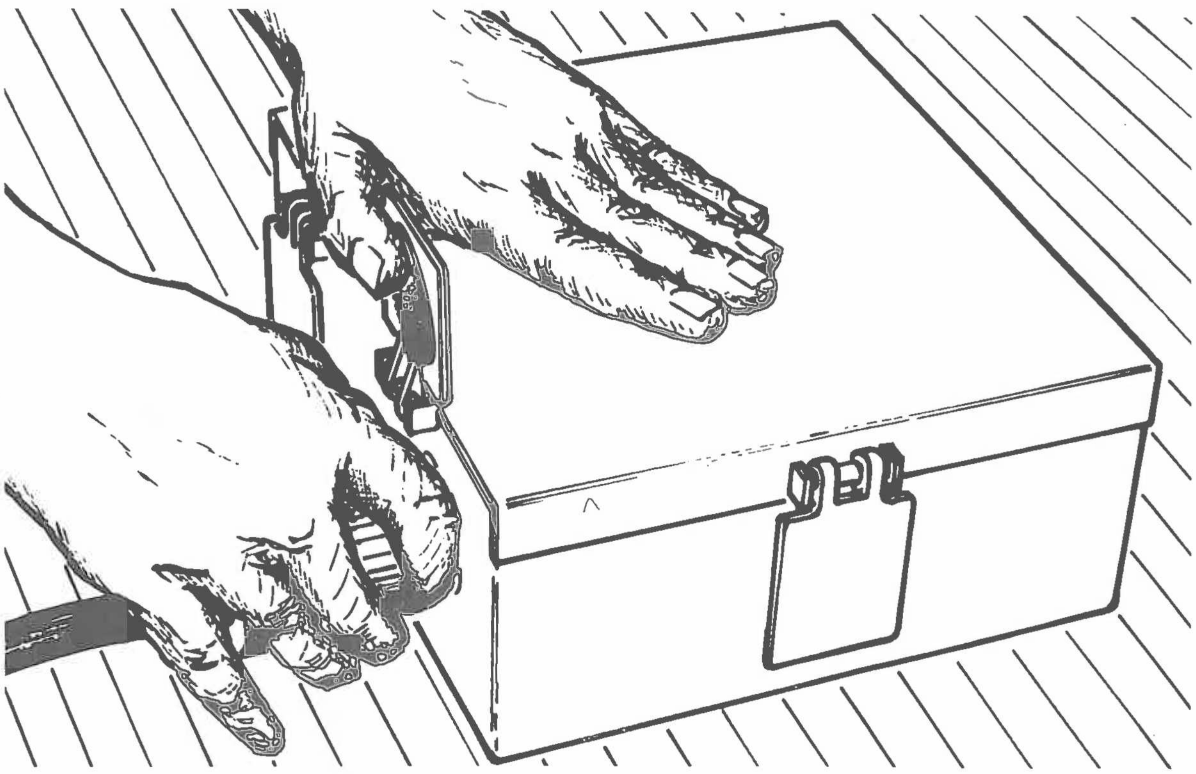
5. All workers, when hired, be made aware of electrical hazards and of safe work practices by which to avoid these hazards. Workers should be informed that, in the event of an electrical injury, no contact should be made with the victim or the electrical apparatus causing the injury until the current has been shut off; and that

6. Workers in the restaurant be encouraged to train in CPR.

We are requesting that editors of appropriate trade journals, health officials, and especially food service inspectors institute and bring these recommendations to the attention of restaurant managers and owners and potential victims. Suggestions, requests for additional information on control practices, or questions related to this announcement should be directed to Mr. John Moran, Director, Division of Safety Research, National Institute for Occupational Safety and Health, 944 Chestnut Ridge Road, Morgantown, West Virginia 26505, Telephone (304) 291-4595.

We greatly appreciate your assistance.

J. Donald Millar, M.D., D.T.P.H. (Lond.)
Assistant Surgeon General
Director, National Institute for
Occupational Safety and Health
Centers for Disease Control



NIOSH

ALERT

DECEMBER 1984

Request for Assistance in Preventing the Injury of Workers by Robots

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

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DHHS (NIOSH) Publication No. 85-103

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National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, Ohio 45226
(513) 841-4287

REQUEST FOR ASSISTANCE IN PREVENTING THE INJURY OF WORKERS BY ROBOTS

BACKGROUND

On July 21, 1984, a thirty-four-year-old male operator of an automated die-cast system went into cardiorespiratory arrest and died after being pinned between the back end of an industrial robot and a steel safety pole. The hydraulic robot had been installed in an existing production line to remove die-cast parts from a die-cast machine and to transfer these parts to a trimmer. The victim had fifteen years' experience in die-casting and had completed a one-week training course in robotics three weeks before the fatal incident.

The victim entered the working range of the operating robot presumably to clean up scrap metal that had accumulated on the floor. Despite training in the robotics course, instructions on the job, and warnings by fellow workers to avoid this dangerous practice, the victim apparently climbed over, through, or around a safety rail which surrounded two sides of the robot's work envelope. The entry point in the safety rail was interlocked. No other presence-sensing devices were operative in the system.

This preventable fatality demonstrates a growing problem of the failure of workers to recognize all the hazards associated with robots. While workers may readily recognize hazards associated with the working zone of the robotic arm, they may not recognize dangers associated with the movement of other parts of the robotic assembly. In this case, the victim was trapped between a fixed object (a steel pole 4-inches in diameter) and the active back end of the robot which was outside the working zone of the robotic arm; the worker apparently presumed this area to be "safe."

RECOMMENDATIONS BY NIOSH

To minimize the risk of such incidents, NIOSH offers the following recommendations regarding the design of robotic systems, the training of workers, and their supervision.

December 1984

A. The Design of Robotic Systems

Regarding both existing robotic equipment and new designs, NIOSH recommends that the robotic system:

1. Include physical barriers that incorporate gates equipped with electrical interlocks so that operation of the robot stops when the gate is opened.

2. Include, as a backup to electrical interlocks, motion sensors, light curtains, or floor sensors that stop the robot whenever a worker crosses the barrier.

3. Provide barriers, as may be appropriate, between robotic equipment and any freestanding objects such as posts limiting robot arm movement so that workers cannot get between any part of the robot and the "pinch points."

4. Provide adequate clearance distances around all moving components of the robotic system. It is of particular importance that this be considered in plans for replacing a human worker with a robot; a robot often requires more operational space than does a human worker doing the same task.

5. Include remote "diagnostic" instrumentation as much as possible so that a maximum amount of troubleshooting of the system can be done from areas outside the operating range of the robot. Whenever it is necessary for a worker to be within the operating range of a robot, additional special provisions for safety should be taken, including, at a minimum, the presence of another worker who can turn off the robot should an emergency develop (buddy system).

6. Provide adequate illumination in the control and operational areas of the robotic system so that written instructions, as well as buttons, levers, etc., are clearly visible.

7. Include on floors or working surfaces clearly visible marks that indicate the zones of movement of the robot.

B. Training of Workers

Training specific to the particular robot in question should be provided to workers who will be programming, operating, or maintaining robots. Moreover, refresher courses which re-emphasize safety and discuss new technological developments should be provided for experienced programmers, operators, and maintenance workers. This training should emphasize safe work practices and stress that:

1. Workers must be familiar with all working aspects of the robot, including full range of motion, known hazards, how the robot is programmed, emergency stop buttons, and safety barriers, before operating or performing maintenance work at robotic work stations.

2. Operators should never be in reach of the robot while it is operating.

3. Programmers, operators, and maintenance workers should operate robots at reduced speeds consistent with adequate worker response to avoid hazards during programming and be aware of all conceivable pinch points, such as poles, walls, and other equipment, in the robots' operational areas.

C. Supervision of Workers

Supervisors should:

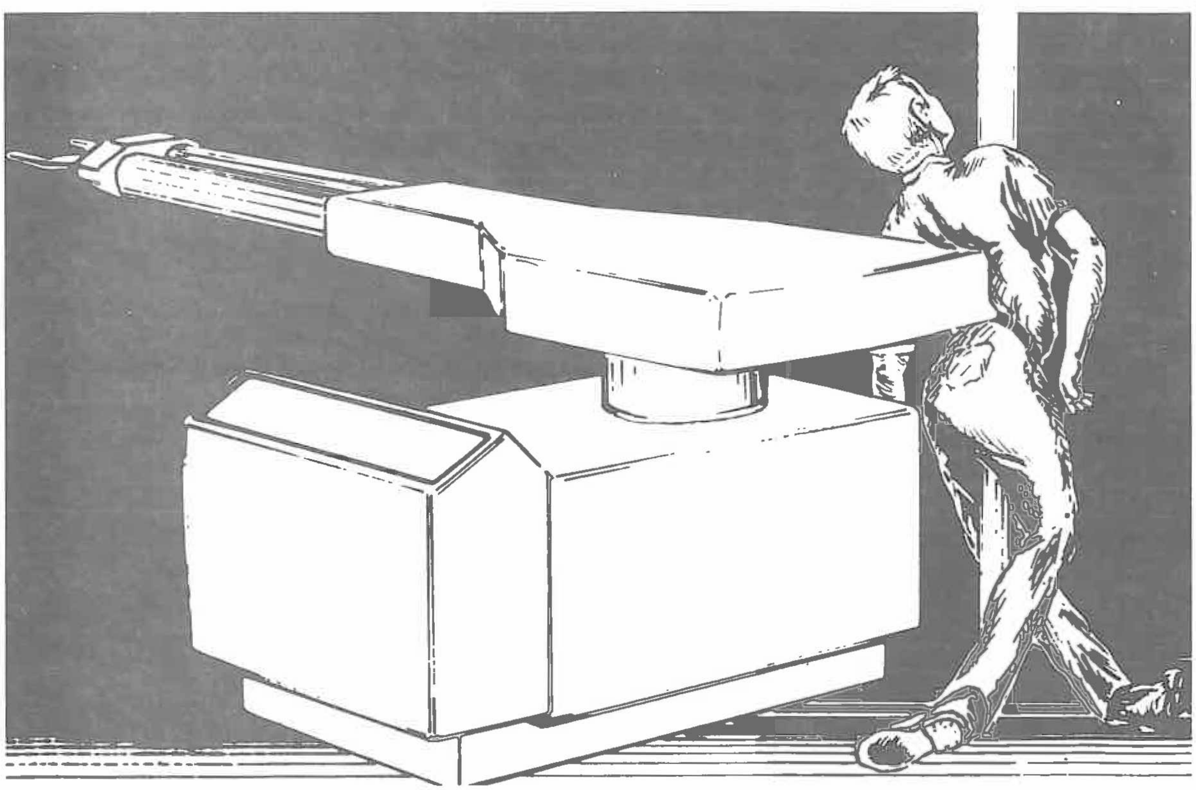
1. Assure that no one is allowed to enter the operational area of a robot without first putting the robot on "hold," in a "power down" condition, or at a reduced operating speed mode.

2. Recognize that with the passage of time, experienced workers doing automated tasks may become complacent, overconfident, or unattentive to the hazards inherent in complex automated equipment. Close supervision of such operations is imperative to assure safety.

We are requesting that company managers, editors of appropriate trade journals, robot equipment designers, and safety and health inspectors institute these recommendations and bring them to the attention of the potential victims.

To report incidents regarding robotics and to obtain assistance or further information, call Mr. John Moran, Director, Division of Safety Research, National Institute for Occupational Safety and Health, 944 Chestnut Ridge Road, Morgantown, West Virginia 26505, Telephone (304) 291-4595.

J. Donald Millar, M.D., D.T.P.H. (Lond.)
Assistant Surgeon General
Director, National Institute for
Occupational Safety and Health
Centers for Disease Control



NIOSH

ALERT

JULY 1985

Request for Assistance in Preventing Electrocutions from Contact Between Cranes and Power Lines

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

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DHHS (NIOSH) Publication No. 85-111

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Cincinnati, Ohio 45226
(513) 841-4287

REQUEST FOR ASSISTANCE IN PREVENTING

ELECTROCUTIONS FROM CONTACT BETWEEN CRANES AND POWER LINES

BACKGROUND

Contact between cranes and overhead power lines is a major cause of fatal occupational injuries in the United States. Based upon an analysis by the National Institute for Occupational Safety and Health (NIOSH) of the data from the Supplementary Data System [1] of the Bureau of Labor Statistics, there were approximately 2,300 lost workday occupational injuries in the United States in 1981 which resulted from contact with electrical current by crane booms, cables, or loads. These 2,300 injuries were extremely severe, resulting in 115 fatalities and 200 permanent total disabilities. Comparable statistics obtained in studies conducted by the National Safety Council from 1964 to 1976 produced an estimated annual average of 150 fatalities resulting from such incidents [2]. NIOSH believes that this type of event is the most common cause of fatalities associated with mobile crane operations [3] and is responsible for approximately 1.5% of all fatal work-related injuries each year.

CASE REPORTS

As part of the Fatal Accident Circumstances and Epidemiology (FACE) Project conducted by NIOSH, six fatal injuries involving crane-related electrocutions were investigated. The synopses of these cases are as follows:

Case #1:

A 28-year-old construction worker was holding on to a steel ladder being moved by a telescoping boom crane. As the crane's boom was swung in the direction of 7,200 volt power lines, the cable contacted the closest of the lines and the worker was electrocuted.

Case #2:

A co-owner of a steel erection company and three workers were using a telescoping boom crane to move a section of a steel framing member at the construction site of a commercial storage shed. As the section was moved, it came into contact with a 23,000 volt overhead power line. Two of the three workers who were in direct contact with the load were electrocuted while the third received serious electrical burns.

Case #3:

Roof materials for an addition to a commercial building were stored outside the building directly beneath a 7,200 volt power line. While hooking a load (joist angle bracing) to the crane, a worker was electrocuted when the cable came into contact with the power line as the boom swung.

Case #4:

A construction company was in the process of laying concrete water pipe with a crane. As workmen were placing support timbers beneath the crane's outrigger pads, the operator began extending the crane boom for the next lift when the boom came into contact with a 3 phase 13,800 volt overhead power line. One worker touching an outrigger of the crane was electrocuted.

Case #5:

At a highway construction site, a carpenter attached a 4' x 8' wood and metal form to a crane. While holding on to the form in attempting to guide it into place, the carpenter was electrocuted when the boom or cable came into contact with a 34,000 volt power line.

APPROPRIATE STANDARDS AND RECOMMENDED WORK PRACTICES

The Occupational Safety and Health Administration (OSHA) Safety and Health Regulations for Construction, Subpart N--Cranes, Derricks, Hoists, Elevators, and Conveyors (29 CFR 1926.550(a)(15)) contains specific requirements for the safe use of cranes proximate to overhead power lines. Electrical distribution and transmission lines are required to be de-energized and visibly grounded, moved, or separated from cranes with independent insulating barriers. The regulation states that when it is not possible to meet these requirements, cranes may operate proximate to power lines only if:

a) minimum clearance (absolute limit of approach) is maintained between the crane and the lines (10 feet for $\leq$50 kV and 10 feet plus 0.4 inch for each 1 kV over 50 kV, or twice the length of the line insulator but never less than 10 feet); or,

b) in transit with no load and boom lowered, minimum clearance (absolute limit of approach) is maintained (4 feet for $<$50 kV, 10 feet for 50 kV to 345 kV, or 16 feet for up to and including 750 kV).

Additionally, 1926.550(a)(15) requires that: a person be designated to observe the clearance of the crane when it is difficult for the crane operator to use direct observation; cage-type boom guards, insulating lines, or proximity warning devices may be used, but their use does not eliminate the need to adhere to the other parts of the regulation; any overhead wire is to be considered energized until the owner of the line or the electric utility indicates that it is not energized and that it has been visibly grounded; transmitter towers should also be de-energized or tests shall be conducted to determine if an electrical charge has been induced on the crane. Induced charges shall be dissipated by providing an electrical ground directly to the upper rotating structure supporting the boom; ground jumper cables shall be attached to materials when an electrical charge is induced; crews shall be provided with nonconductive poles to attach the ground cable to the load; combustible and flammable materials shall be removed from the immediate area prior to operations.

The Construction Safety Association of Ontario, Canada (CSA-Ontario), recommends safe work practices [4] beyond those addressed in the OSHA standard including the use of nonconductive taglines to guide loads and the use of insulating personal protective equipment by exposed workers.

APPLICATION OF EXISTING STANDARDS AND RECOMMENDED WORK PRACTICES

Table 1 presents an analysis for each of the five cases described in this alert regarding compliance with the OSHA standard or CSA-Ontario recommended work practices. In two of the cases, neither the OSHA standard nor the CSA-Ontario recommended work practices were being followed. In the remaining three cases, only one of these safe work practices (avoiding the storage of materials directly under power lines) was being followed. In each of these five cases, there was demonstrable lack of compliance with the OSHA standard.

CONCLUSION

The principal objective of the investigations undertaken by NIOSH as part of its Fatal Accident Circumstances and Epidemiology (FACE) Project is to determine what factors enabled the fatality to occur. The goal is to learn how such fatalities can be prevented. In this context, whether or not an operation was "in compliance" with existing standards is but one of many variables which may or may not have contributed to the fatality. However, in the course of the investigations reported here, it became obvious that full compliance with relevant OSHA standards and full use of the CSA-Ontario work practices would have prevented each fatality.

As an obvious first step in preventing such fatalities in the future, we conclude that all such operations should be done only in compliance with existing OSHA standards.

TABLE 1

Status of Compliance with OSHA Standards (or Use of CSA-Ontario Recommended Work Practices) in Operations Which Resulted in Six Crane-related Electrocutions

Relevant OSHA Standard (or CSA-Ontario Recommended Work Practice)	Status of Compliance by Case				
	#1	#2	#3	#4	#5
1. Move, insulate, or de-energize power line before starting work (OSHA)	No	No	No	No	No
2. Maintain recommended absolute limit of approach (minimum clearance) for specific voltage (OSHA)	No	No	No	No	No
3. Utilize a signal man (OSHA)	No	No	No	No	No
4. Utilize nonconductive taglines, rather than direct contact, to stabilize load (CSA-Ontario)	No	No	No	No	No
5. Do not store combustible materials directly beneath power lines (OSHA & CSA-Ontario)	No	Yes	No	Yes	Yes
6. Use boom guards, insulating lines, or proximity warning devices in addition to other requirements (OSHA)	No	No	No	No	No
7. Use insulating boots and gloves when workers connect loads or contact the crane while in the vicinity of overhead power lines (CSA-Ontario)	No	No	No	No	No

No = Data demonstrated lack of compliance with the OSHA standard (or lack of use of CSA-Ontario recommended work practices).

Yes = Data demonstrated compliance with the OSHA standard (or use of CSA-Ontario recommended work practices).

RECOMMENDATIONS BY NIOSH

The existing OSHA standard appears sufficient to prevent the crane-related electrocutions described in this alert as well as all others. NIOSH urges all employers who use cranes in the vicinity of overhead power lines to familiarize themselves with and implement the existing OSHA standard. NIOSH urges safety and trade associations, crane manufacturers, electric utility companies, and OSHA state consultative services to bring this standard to the attention of employers who use cranes. Implementation of the work practices described by the CSA of Ontario can provide an additional margin of safety.

Suggestions, requests for additional information on safe work practices, or questions related to this announcement should be directed to Mr. John Moran, Director, Division of Safety Research, 944 Chestnut Ridge Road, Morgantown, West Virginia 26505-2888, Telephone (304) 291-4595.

We greatly appreciate your assistance.

J. Donald Millar, M.D., D.T.P.H., (Lond.)
Assistant Surgeon General
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NIOSH

ALERT

JULY 1985

Request for Assistance in Preventing Deaths and Injuries from Excavation Cave-ins

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

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REQUEST FOR ASSISTANCE IN PREVENTING

DEATHS AND INJURIES FROM EXCAVATION CAVE-INS

BACKGROUND

Excavation cave-ins cause serious and often fatal injuries to workers in the United States. An analysis by the National Institute for Occupational Safety and Health (NIOSH) of workers' compensation claims for 1976 to 1981 [1] in the Supplementary Data System of the Bureau of Labor Statistics suggests that excavation cave-ins caused about 1,000 work-related injuries each year. Of these, about 140 result in permanent disability and 75 in death. Thus, this type of incident is a major cause of deaths associated with work in excavations and accounts for nearly 1% of all annual work-related deaths in the nation.

CASE REPORTS

As part of the Fatal Accident Circumstances and Epidemiology (FACE) Project of NIOSH, four deaths caused by excavation cave-ins were recently investigated. Synopses of these cases follow:

Case #1:

A 53-year-old laborer employed by a city sewer department entered an 11 1/2-foot-deep unshored, vertical-walled, manhole excavation in order to lower and level the area where the manhole foundation was to be set. As he was leaving the excavation after completing this task, one wall collapsed burying him completely and killing him.

Case #2:

A 22-year-old laborer was manually digging a dry well and a trench 8 feet deep for a drainage pipe connection. None of the walls of the excavated areas were shored or sloped to a safe angle of repose, i.e., the greatest angle above the horizontal plane at which a material will lie without sliding. As the worker was digging the trench, one wall collapsed covering him with 6 feet of soil and killing him.

Case #3:

A 45-year-old construction "lead man" was shoveling loose dirt from the bottom of a 21-foot-deep unshored, vertical-walled excavation to accommodate placement of a fabricated trench shield. Soil began falling from a side wall; as the worker attempted to leave the site, the soil "gave way" entirely covering and killing him.

Case #4:

A 32-year-old construction field foreman was standing in an unshored, vertical-walled excavation approximately 7 feet deep. One wall caved in, knocking the foreman down, entirely covering him with soil and killing him.

APPROPRIATE STANDARDS AND RECOMMENDED WORK PRACTICES

Standards promulgated by the Occupational Safety and Health Administration (OSHA) establish specific requirements intended to protect workers in excavations and trenches (29 CFR 1926.651 and .652, respectively). Basically, these standards require that walls and faces of all excavations in which workers are potentially exposed to danger from moving ground be guarded by a shoring system, safe sloping of the ground, or equivalent means of protection such as trench shields or boxes. However, the standards are applicable only to trenches 5 feet or more in depth.

A table published in 29 CFR 1926.652 indicates the required horizontal-to-vertical ratio for sloping the sides of excavations as they relate to specific types of soil. These requirements are intended to approximate, for each soil type, the safe angle of repose. The standards also define minimum requirements for shoring of trenches for various classifications of soils. The standards require additional shoring and bracing procedures when excavations or trenches are located adjacent to previously backfilled excavations or where excavations are subjected to vibrations from railroad or highway traffic, the operation of machinery, or other sources.

A major issue surrounding existing OSHA standards for excavations, trenching, and shoring is the classification of soils. Soil classification provides an empirical estimation of the soil's stability. If the potential for cave-ins or other dangerous movements of ground is thought to exist, appropriate decisions to provide adequate protection must be reached. Regarding soil classification, however, critics have described the existing standards as vague and confusing and subject to dangerously variable interpretation [2].

Recently, the National Bureau of Standards (NBS) and NIOSH jointly published Development of Draft Construction Safety Standards for Excavations, DHHS (NIOSH) Publication No. 83-103 [3]. This document recommends establishing a requirement to provide protection in excavations 5 feet deep or greater regardless of soil type. It also presents a simplified soil classification system for use in determining appropriate side-sloping requirements and for calculating the lateral soil pressures imposed on shoring systems.

APPLICATION OF EXISTING STANDARDS AND RECOMMENDED WORK PRACTICES

In the fatal incidents described above, none of the excavations were found to incorporate those protective measures specified in applicable OSHA Standards or the joint NBS/NIOSH publication. Table 1 suggests that compliance with existing regulations or adherence to recommended work practices might have prevented important causative circumstances in each of the four fatal incidents.

CONCLUSION

The principal objective of the investigations undertaken by NIOSH as part of its Fatal Accident Circumstances and Epidemiology (FACE) Project is to determine what factors enabled the fatality to occur. The goal is to learn how such fatalities can be prevented. In this context, whether or not an operation was "in compliance" with existing standards is but one of many variables which may or may not have contributed to the fatality. However, in the course of investigations reported here, it became obvious that full compliance with relevant OSHA standards or application of the NBS/NIOSH recommended work practices would probably have prevented each fatality.

As an obvious first step in preventing such fatalities in the future, we conclude that all such operations should be done only in full compliance with existing OSHA standards.

TABLE 1

Status of Compliance with Standards (or NBS/NIOSH Recommended Work Practices) in Operations Which Resulted in the Four Fatal Excavation Cave-ins

Relevant OSHA Standards	Status of Compliance by Case			
	#1	#2	#3	#4
1. The walls and faces of all excavations in which employees are exposed to danger from moving ground[1] shall be guarded by a shoring system, sloping of the ground, or some other equivalent means. (29 CFR 1926.651 (c))	No	No	No[2]	No
2. Sides of trenches in unstable or soft material[1], 5 feet or more in depth, shall be shored, sheeted, braced, sloped, or otherwise supported by means of sufficient strength to protect employees working within them. (29 CFR 1926.652 (b), Tables P-1 and P-2)	No	No	No	No
3. Excavations (including trenches) adjacent to backfilled areas or subjected to vibrations[1] from railroads, highway traffic, or operation of machinery shall have additional shoring and bracing precautions taken. (29 CFR 1926.651 (m) and 1926.652 (e))	No	NA	No	No
Relevant Recommended Work Practices (NBS/NIOSH) [3]				
1. Excavations[3] from 5 feet to 24 feet[4] deep in Type A and Type B soils or 5 feet to 15 feet deep in Type C soil shall either be: provided with a shoring system capable of supporting the lateral soil pressure, cut back to the steepest allowable slope for the type of soil, or a combination of both measures. Stable rock is exempt. (Vibration energies have been taken into consideration in the requirement of shoring systems or sloping.)	No	No	No	No

1 Subjective, vague, or unclear as to applicability.
2 One hydraulic shore was in use on an intersecting trench.
3 Excavations include trenches; no distinction between them is made as in present OSHA standards.
4 In all excavations deeper than 24 feet, except those in unfractured rock, an engineer (qualified person) shall determine the shoring, shielding, or sloping requirements.
NA Not applicable

RECOMMENDATIONS BY NIOSH

The consistent absence of evidence of compliance with existing regulations in the four incidents described above suggests that employers are either (1) unaware of the existence of the OSHA standards or (2) misinterpreting the requirements of the standards as regards exemptions based on characteristics of the soil.

NIOSH recommends that:

- **shoring systems or sloping of the walls be used in all excavations 5 to 24 feet deep in any type of soil, except solid, stable rock.**

- **appropriate shoring, shielding, or sloping requirements for all excavations deeper than 24 feet (except those in unfractured rock) be determined by an engineer qualified to make these determinations.**

- **all employers engaged in excavation activities familiarize themselves with the provisions of the NBS/NIOSH document (Development of Draft Construction Safety Standards for Excavations) and implement them as safe work practices in addition to compliance with the existing OSHA standards.**

We urge safety and trade associations, underground utility companies, municipalities and other local governments responsible for underground utility services, as well as state OSHA consultative services to bring these recommendations to the attention of employers engaged in excavations.

Suggestions, requests for additional information on safe work practices, or questions related to this announcement should be directed to Mr. John Moran, Director, Division of Safety Research, 944 Chestnut Ridge Road, Morgantown, West Virginia 26505, Telephone (304) 291-4595.

Thank you for your help in protecting the lives and health of America's workers.

J. Donald Millar, M.D., D.T.P.H. (Lond.)
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NIOSH

ALERT

JULY 1985

Request for Assistance in Preventing Hazards in the Use of Water Spray (Fog) Streams to Prevent or Control Ignition of Flammable Atmospheres

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

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(513) 841-4287

REQUEST FOR ASSISTANCE IN PREVENTING

HAZARDS IN THE USE OF WATER SPRAY (FOG) STREAMS

TO PREVENT OR CONTROL IGNITION OF FLAMMABLE ATMOSPHERES

WARNING!

FIRE DEPARTMENTS AND TEAMS RESPONDING TO INCIDENTS INVOLVING FLAMMABLE GAS OR VAPOR MIXTURES ARE CAUTIONED THAT THE USE OF WATER SPRAY (FOG) STREAMS TO PREVENT IGNITION OR CONTROL FLAME PROPAGATION MAY BE EXTREMELY DANGEROUS:

- SIGNIFICANT FIRES OR EXPLOSIONS CAN OCCUR DESPITE THE USE OF WATER SPRAY. UNDER CERTAIN CONDITIONS, THE USE OF WATER SPRAY MAY IN FACT INCREASE THE SEVERITY OF SUCH FIRES AND EXPLOSIONS.

- IT IS UNLIKELY THAT HANDLINES USING STANDARD FIRE DEPARTMENT WATER SPRAY (FOG) NOZZLES UNDER FIELD CONDITIONS CAN PREVENT IGNITION.

- IT IS UNLIKELY THAT HANDHELD HOSE STREAMS CAN PRODUCE A WATER SPRAY WITH SUFFICIENTLY SMALL DROPLET SIZE AND UNIFORMLY HIGH WATER CONCENTRATIONS TO RENDER INERT A FLAMMABLE ATMOSPHERE.

- THE USE OF WATER SPRAY CANNOT BE RELIED UPON TO QUENCH A FIRE IN A FLAMMABLE ATMOSPHERE.

INTRODUCTION

In response to requests for assistance by Federal, state, and local health agencies who have jurisdiction, the National Institute for Occupational Safety and Health (NIOSH) conducts selected investigations of occupational fatalities. Recently NIOSH was called to investigate an incident which occurred as a hazardous materials (HAZMAT) team responded to a "man down" emergency in a storage tank recently emptied of toluene. In the attempt to gain immediate access to the tank to rescue the victim, members of the team began to saw an opening in the side of the tank while blanketing the area being cut with water fog, both inside and outside the tank. An explosion occurred which instantly killed one HAZMAT team member and injured 15 others.

July 1985

BACKGROUND

Water, in the form of "water spray" or "fog patterns," is frequently used by fire departments and other response teams to prevent or control fire when dealing with flammable materials. The use of water sprays in this way derives from several factors:

- traditional use of water by firefighters to extinguish fires,
- belief that water sprays may provide critical ventilation,
- ready availability and relative ease of application of water sprays, and
- effectiveness of water sprays in controlling some of the hazards of flammable materials.

In investigating the circumstances of the incident summarized above, investigators from NIOSH also reviewed various reported uses of water sprays to control hazardous materials.* This review identified at least 20 different suggested uses of water in the control of hazardous materials. In at least some of the situations described, the use of water fog actually posed a significant additional risk to the safety of firefighters or other personnel. One example is the attempt to prevent, control, or diminish a gas-air or vapor-air explosion using water spray or fog delivered by handlines.

Accordingly, this alert, directed to fire departments and HAZMAT teams specifically, warns that certain uses of water may be hazardous. These dangerous uses of water should be avoided.

REPORTED USES OF WATER SPRAYS

Studies by numerous laboratories have identified four prime mechanisms through which water spray could influence the ignition and propagation of a fire or explosion in a flammable atmosphere. Water spray has been used to:

- ventilate or otherwise reduce the concentration of the fuel to a level below that which is flammable,
- raise the required ignition energy beyond that available,
- render the flammable atmosphere inert, or
- quench or prevent the propagation of an incipient or developed flame front.

*The National Institute for Occupational Safety and Health (NIOSH) intends to publish a more detailed report on water spray at a later date.

The water spray requirements for each of these control mechanisms differ, as do their methods of application. Experience with use of water sprays for these purposes, including potential hazards, is briefly summarized below.

1. Concentration Reduction

Various techniques involving use of water spray have proven successful in laboratory and field trials and in some actual incidents. For example, air entrained in water spray has been shown to dilute, ventilate, or move flammable vapors or gases. In addition, water droplets in spray may absorb soluble vapors or gases under certain conditions.

However, in some experimental cases the water spray did not reduce the concentration of flammable vapors below the threshold of flammability, and ignition occurred. In those instances, the flame traveled through the water spray resulting in a more severe fire or explosion than would have occurred without the water spray.

2. Raising Required Ignition Energy

The results of several laboratory studies indicate that water sprays directed on "hot spots" caused by frictional cutting can significantly reduce the likelihood of ignition. By using a fine water spray directed on the hot path of a mining bit cutting into rock, researchers have prevented ignition of a flammable methane-air mixture. The water density of the covering spray, the size of droplets, and the work surface being cooled were critical factors in the success of this control measure.

Other studies using an explosive as the source of ignition of flammable ethylene-air or hydrogen-air mixtures showed that the strength of the charge necessary to obtain an explosion was considerably increased with the use of a water spray. In both situations, however, higher levels of ignition energy still caused ignitions, i.e., the water spray was not sufficiently effective to prevent ignition.

3. Rendering a Flammable Atmosphere Inert

Water as steam can render a flammable atmosphere inert. For example, when the concentration of water in the atmosphere was about 26% by volume, a highly flammable methane-air mixture was rendered inert. This concentration of water in the atmosphere is approximately 10 times that which the atmosphere can normally contain at room temperatures. This approach is normally impractical for field use because it requires production of a droplet size 30-100 times finer than that produced by standard fire department water spray (fog) equipment.

4. Quenching Flame Propagation

Quenching, or cooling a flame below the temperature required to propagate it in a flammable atmosphere, can be achieved only if the water droplets can be made small enough so that the distance between them is below a critical dimension. To produce a sufficiently fine mist in a fixed spray system usually requires a pressure in excess of 1,000 psig. Further, some systems even require the use of a high explosive to break up and disperse the water droplets.

Fire departments and other teams responding to incidents involving flammable gas or vapor mixtures are urged to approach the control of flammable atmospheres with extreme caution. The use of a water spray (fog) does not eliminate the need for other recognized control methods to dilute the flammable atmosphere and to prevent ignition due to sparks, arcs, or open flames.

REQUEST FOR ASSISTANCE

NIOSH requests that the technical information and warning contained in this ALERT be disseminated to personnel of fire departments, HAZMAT teams personnel, fire training academies, and other emergency response organizations.

Should further information be desired, please contact the Division of Safety Research, 944 Chestnut Ridge Road, Morgantown, West Virginia 26505-2888, Telephone (304) 291-4809.

We greatly appreciate your assistance.

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NIOSH

JANUARY 1986

ALERT

Request for Assistance in Preventing Occupational Fatalities in Confined Spaces

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

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REQUEST FOR ASSISTANCE IN PREVENTING OCCUPATIONAL FATALITIES IN CONFINED SPACES

SUMMARY

This Alert requests the assistance of managers, supervisors, and workers in the prevention of deaths that occur in confined spaces. Confined spaces may be encountered in virtually any occupation; therefore, their recognition is the first step in preventing fatalities. Since deaths in confined spaces often occur because the atmosphere is oxygen deficient or toxic, confined spaces should be tested prior to entry and continually monitored. More than 60% of confined space fatalities occur among would-be rescuers; therefore, a well-designed and properly executed rescue plan is a must. This Alert describes 16 deaths that occurred in a variety of confined spaces. Had these spaces been properly evaluated prior to entry and continuously monitored while the work was being performed and had appropriate rescue procedures been in effect, none of the 16 deaths would have occurred. There are no specific OSHA rules that apply to all confined spaces. Recommendations for Recognition, Testing, Evaluation, and Monitoring, and Rescue of Workers are presented. Other National Institute for Occupational Safety and Health (NIOSH) publications on this subject as well as a source for additional information and assistance are also presented.

January 1986

BACKGROUND

The deaths of workers in confined spaces constitute a recurring occupational tragedy; approximately 60% of these fatalities have involved would-be rescuers. If you are required to work in a:

SEWER	**STORAGE TANK**	**SHIP'S HOLD**
SEPTIC TANK	**SILO**	**REACTION VESSEL**
SEWAGE DIGESTER	**VAT**	**BOILER**
PUMPING/LIFT STATION	**DUCT**	**PIPELINE**
SEWAGE DISTRIBUTION or HOLDING TANK	**UTILITY VAULT**	**PIT**

or similar type of structure or enclosure, you are working in a **CONFINED SPACE**. The Occupational Safety and Health Administration (OSHA) defines a confined space in 29 CFR 1926.21 as "any space having a limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere." The NIOSH Criteria for a Recommended Standard....Working in Confined Spaces dated December, 1979, defines a confined space as:

> ...a space which by design has limited openings for entry and exit; unfavorable natural ventilation which could contain or produce dangerous air contaminants, and which is not intended for continuous employee occupancy. Confined spaces include but are not limited to storage tanks, compartments of ships, process vessels, pits, silos, vats, degreasers, reaction vessels, boilers, ventilation and exhaust ducts, sewers, tunnels, underground utility vaults, and pipelines.

CASE REPORTS OF FATAL INCIDENTS

Case #1 - RECOGNITION AND RESCUE (FATALITIES = 1 WORKER + 1 RESCUER)

On December 29, 1983, a 54-year-old worker died inside a floating cover of a sewage digester while attempting to restart a propane heater that was being used to warm the outside of the sewage digester cover prior to painting it. Workers had wired the safety valve open so that the flow of propane would be constant, even if the flame went out. The heater was located near an opening in the cover of the digester. When the worker attempted to restart the heater, an explosion occurred that vented through the opening. The worker crawled away from the heater into an area that was oxygen deficient and died. A co-worker attempted a rescue and also died.

Case #2 - RECOGNITION AND RESCUE (FATALITIES = 1 WORKER + 1 RESCUER)

On March 8, 1984, a 20-year-old construction worker died while attempting to refuel a gasoline engine powered pump used to remove waste water from a 66 inch diameter sewer line that was under construction. The pump was approximately 3,000 feet from where the worker had entered the line. The worker was overcome by carbon monoxide. A co-worker, who had also entered the sewer line, escaped. A 28-year-old state inspector entered from another point along the sewer line and died in a rescue attempt. Both deaths were due to carbon monoxide intoxication. In addition to the fatalities, 30 firefighters and 8 construction workers were treated for carbon monoxide exposure.

Case #3 - RECOGNITION AND RESCUE (FATALITIES = 2 RESCUERS)

On October 4, 1984, two workers (26 and 27 years old) were overcome by gas vapors and drowned after rescuing a third worker from a fracturing tank at a natural gas well. The tank contained a mixture of mud, water, and natural gas. The first worker had been attempting to move a hose from the tank to another tank. The hose was secured by a chain and when the worker moved the hose, the chain fell into the tank. The worker entered the tank to retrieve the chain and was overcome.

Case #4 - RECOGNITION AND RESCUE (FATALITIES = 1 WORKER + 1 RESCUER)

On December 5, 1984, a 22-year-old worker died inside a toluene storage tank that was 10 feet in diameter and 20 feet high while attempting to clean the tank. The worker entered the tank through the 16 inch diameter top opening using a 1/2 inch rope for descent. Although a self-contained breathing apparatus was present, the worker was not wearing it when he entered the tank. The worker was overcome and collapsed onto the floor of the tank. In an attempt to rescue the worker, fire department personnel began cutting an opening into the side of the tank. The tank exploded, killing a 32-year-old firefighter and injuring 15 others.

Case #5 - RECOGNITION AND RESCUE (FATALITIES = 1 WORKER + 1 RESCUER)

On May 13, 1985, a 21-year-old worker died inside a waste water holding tank that was four feet in diameter and eight feet deep while attempting to clean and repair a drain line. Sulfuric acid was used to unclog a floor drain leading into the holding tank. The worker collapsed and fell face down into six inches of water in the bottom of the tank. A second 21-year-old worker attempted a rescue and was also overcome and collapsed. The first worker was pronounced dead at the scene and the second worker died two weeks later. Cause of death was attributed to asphyxiation by methane gas. Sulfuric acid vapors may have also contributed to the cause of death.

Case #6 - RECOGNITION AND RESCUE (FATALITY = 1 RESCUER)

On June 7, 1985, a 43-year-old father died while attempting to rescue his 28-year-old son from a tank used to store spent acids from a metal pickling process. The tank was out of service so that sludge could be removed from the bottom. The son collapsed in the tank. The father attempted a rescue and also collapsed. The two were removed from the tank; the son was revived, but the father died. The cause of death is unknown.

Case #7 - RECOGNITION (FATALITY = 1 WORKER)

On July 2, 1985, a crew foreman became ill and was hospitalized after using an epoxy coating, which contained 2-nitropropane and coal tar pitch, to coat a valve on an underground waterline. The valve was located in an enclosed service vault (12' x 15' x 15'). The worker was released from the hospital on July 3, 1985, but was readmitted on July 6, 1985; he lapsed into a coma and died on July 12, 1985, as a result of acute liver failure induced by inhalation of 2-nitropropane and coal tar pitch vapors. A co-worker was also hospitalized, but did not die.

Case #8 - RECOGNITION AND RESCUE (FATALITIES = 1 WORKER + 3 RESCUERS)

On July 5, 1985, a 27-year-old sewer worker entered an underground pumping station (8' x 8' x 7') via a fixed ladder inside a three foot diameter shaft. Because the work crew was unaware of procedures to isolate the work area and ensure that the pump had been bypassed, the transfer line was still under pressure. Therefore, when the workers removed the bolts from an inspection plate that covered a check valve, the force of the waste water blew the inspection plate off, allowing sewage to flood the chamber, and trapping one of the workers. A co-worker, a supervisor, and a policeman attempted a rescue and died. The first two deaths appeared to be due to drowning and the latter two appeared to be due to asphyxiation as a result of inhalation of "sewer gas."

REGULATORY STATUS

As stated in the Regulatory Program of the United States Government (Confined Spaces [29 CFR 1910], page 282 dated August, 1985), "there are no specific OSHA rules directed toward all confined-space work, forcing OSHA compliance personnel to cite other marginally applicable standards or section 5(a)(1) in cases involving confined spaces. For this reason, OSHA field personnel have frequently and strongly recommended the promulgation of a specific standard on confined spaces." In the document Criteria for a Recommended Standard....Working in Confined Spaces, the National Institute for Occupational Safety and Health (NIOSH) has provided comprehensive recommendations for assuring the safety and well-being of persons required to work in confined spaces including a proposed classification system and checklist that may be applied to different types of confined spaces.

CONCLUSIONS

The case studies described above are summarized in Table 1 (see page 6):

TABLE I

SELECTED CHARACTERISTICS OF INCIDENTS OF OCCUPATIONAL FATALITY IN CONFINED SPACE

				DEATHS			
CASE	DATE	TYPE OF SPACE	TYPE OF HAZARD	WORKER	RESCUER	TOTAL	COMMENT
#1	12/29/83	Sewage digester	Oxygen deficiency	1	1	2	-
#2	3/8/84	Sewer line construction	Toxic atmosphere; physical hazard	1	1	2	38 others injured
#3	10/4/84	Fracturing tank	Oxygen deficiency	0	2	2	2 rescuers drowned
#4	12/5/84	Toluene storage tank	Toxic atmosphere; explosion; limited entry and exit	1	1	2	15 others injured
#5	5/13/85	Waste water tank	Toxic atmosphere; physical hazard	1	1	2	Rescuer died two weeks later
#6	6/7/85	"Spent" acid storage tank	Toxic atmosphere	0	1	1	Rescuer was father of worker
#7	7/2/85	Underground waterline, valve area	Toxic atmosphere	1	0	1	Worker died of acute liver failure; another worker ill but recovered
#8	7/5/85	Sewage pumping station	Physical hazard; toxic atmosphere	1	3	4	2 died of drowning; 2 of asphyxiation
			TOTALS	6	10	16	53 others injured

Based on the information derived from these case studies, NIOSH concludes that these fatalities occurred as a result of encountering one or more of the following potential hazards:

- o lack of natural ventilation,
- o oxygen deficient atmosphere,
- o flammable/explosive atmosphere,
- o unexpected release of hazardous energy,
- o limited entry and exit,
- o dangerous concentrations of air contaminants,
- o physical barriers or limitations to movement, or
- o instability of stored product.

In each of these cases there was a lack of **RECOGNITION and TESTING, EVALUATION, and MONITORING** prior to entry nor had a well-planned **RESCUE** been attempted.

These incident reports suggest that **RECOGNITION** of what is a confined space in conjunction with the proper **TESTING, EVALUATION, and MONITORING** of the atmosphere and development of appropriate **RESCUE** procedures could prevent such deaths. These three steps are discussed below.

NIOSH investigations indicate that workers usually do not **RECOGNIZE** that they are working in a confined space and that they may encounter unforeseen hazards. **TESTING and EVALUATION** of the atmosphere are typically not initiated prior to entry and **MONITORING** is not performed during the confined space work procedures. **RESCUE** is seldom planned and usually consists of spontaneous reaction in an emergency situation.

RECOMMENDATIONS

In light of findings to date regarding occupational deaths in confined spaces, NIOSH recommends that managers, supervisors, and workers be made familiar with the following three steps:

1. RECOGNITION

Worker training is essential to the **RECOGNITION** of what constitutes a confined space and the hazards that may be encountered in them. This training should stress that death to the worker is the likely outcome if proper precautions are not taken before entry is made.

2. TESTING, EVALUATION, AND MONITORING

All confined spaces should be **TESTED** by a qualified person before entry to determine whether the confined space atmosphere is safe for entry. Tests should be made for oxygen level, flammability, and known or suspected toxic substances. **EVALUATION** of the confined space should consider the following:

- o methods for isolating the space by mechanical or electrical means (i.e., double block and bleed, lockout, etc.),
- o the institution of lockout-tagout procedures,
- o ventilation of the space,
- o cleaning and/or purging,
- o work procedures, including use of safety lines attached to the person working in the confined space and its use by a standby person if trouble develops,
- o personal protective equipment required (clothing, respirator, boots, etc.),
- o special tools required, and
- o communications system to be used.

The confined space should be continuously **MONITORED** to determine whether the atmosphere has changed due to the work being performed.

3. RESCUE

RESCUE procedures should be established before entry and should be specific for each type of confined space. A standby person should be assigned for each entry where warranted. The standby person should be equipped with rescue equipment including a safety line attached to the worker in the confined space, self-contained breathing apparatus, protective clothing, boots, etc. The standby person should use this attached safety line to help rescue the worker. The rescue procedures should be practiced frequently enough to provide a level of proficiency that eliminates life-threatening rescue attempts and ensures an efficient and calm response to any emergency.

OTHER HELPFUL PUBLICATIONS BY NIOSH

NIOSH has published the following documents which contain further information:

Criteria for a Recommended Standard....Working in Confined Spaces, DHEW Publication No. 80-106.

Guidelines for Controlling Hazardous Energy During Maintenance and Servicing, DHHS Publication No. 83-125.

We ask that editors of appropriate trade journals and safety and health officials (i.e., inspectors, managers, and hygienists, especially those associated with work in confined spaces) bring these recommendations to the attention of workers, supervisors, managers, and owners.

Requests for additional information on control practices or questions related to this announcement should be directed to Mr. John Moran, Director, Division of Safety Research, National Institute for Occupational Safety and Health, 944 Chestnut Ridge Road, Morgantown, West Virginia 26505, Telephone (304) 291-4595.

We greatly appreciate your assistance.

J. Donald Millar, M.D., D.T.P.H. (Lond.)
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Centers for Disease Control

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Request for Assistance in

Preventing Grain Auger Electrocutions

July 1986

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

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REQUEST FOR ASSISTANCE IN PREVENTING GRAIN AUGER ELECTROCUTIONS

WARNING!

MOVING GRAIN AUGERS IN THEIR ELEVATED POSITION MAY RESULT IN ELECTROCUTION IF THEY CONTACT OVERHEAD POWER LINES WHILE BEING MOVED. FARM OWNERS AND MANAGERS SHOULD ENSURE THAT AUGERS ARE IN THE LOWERED POSITION PRIOR TO MOVING THEM.

SUMMARY

This Alert requests the assistance of farm owners/managers, farm/agricultural workers, and farm equipment manufacturers in the prevention of electrocutions which may occur while moving metal grain augers. The grain auger is an essential piece of farm equipment which is used to move grain from one location to another. However, every year accidents occur when this piece of equipment is improperly moved in the elevated position and it comes into contact with high voltage power lines. This has resulted in one or more fatalities per incident. This Alert describes two separate incidents that resulted in five fatalities, and occurred within the same week (150 miles apart). Neither of the incidents fell under OSHA jurisdiction because both farms were family operations employing fewer than 10 workers.

July 1986

BACKGROUND

The grain auger is a portable piece of farm equipment, 50 to 60 feet long, and weighing several hundred pounds. It is used to move grain from one location to another (e.g., unloading grain from a truck or trailer and loading it into a dryer or storage bin). It is moved to a desired location on inflatable-type car tires and then raised into position by means of a hand crank attached to a steel pully system; the discharge end is elevated to the top of a dryer or bin, and the opposite end is lowered in order to pick up the grain to be moved. The auger is usually powered by connecting a universal joint to the power takeoff on a tractor or other piece of farm equipment. After transferring the grain, the auger should be lowered to a horizontal position for safe transportation to another location. However, the auger is not always lowered before being moved, and this unsafe practice could pose a life threatening hazard if the auger comes into contact with overhead electrical lines or if it were to tip over during transport.

CASE REPORTS OF TWO FATAL INCIDENTS

These case reports resulted from NIOSH investigations of the circumstances that led to the five fatalities described below. The investigations were conducted as part of the NIOSH Fatal Accident Circumstances and Epidemiology Program.

Case #1 - TWO ELECTROCUTED, THREE INJURED

During mid-morning on October 14, 1985, five farm workers were in the process of moving a portable grain auger. To move the auger from a 30-foot tall grain drying bin to another location, it was raised to approximately 35 feet (an angle of about 45 degrees) so that the top could clear the bin. The workers then pulled the grain auger machine back approximately 15 feet from the grain bin, rotated the rear of the auger 90 degrees, and began pushing the auger to the new location. As the workers pushed the auger forward, approximately 90 feet, it contacted an electrical line which was about 25 feet above the ground. Two of the workmen were electrocuted and three others were injured.

Case #2 - THREE ELECTROCUTED

During the early morning of October 18, 1985, two farm workers and the farm owner were moving a portable grain auger from a grain bin, approximately 30 feet high, to another location. The auger was first raised to 35 feet to clear the top of the grain bin and then pulled back approximately 15 feet. The workers swiveled the auger 90 degrees to allow a straight path to the truck, approximately 40 yards away, that was to be loaded with grain. As the workers pushed the auger forward, it contacted a 7200 volt electrical line which was 25 feet above the ground. The two workers and the farm owner were electrocuted.

REGULATORY STATUS

OSHA estimates that over 90% of all farms in the United States are not covered by OSHA regulations. OSHA regulations are not applicable to most farms because they employ fewer than 10 employees. However, for farms employing 11 or more workers (family members do not count in this number), OSHA jurisdiction does apply and mandatory compliance is required to 29 CFR 1928.57, Guarding of Farm Field Equipment, Farm Machinery & Farmstead, Sub Part D.

CONCLUSIONS

Based on the information collected on the two cases cited, it can be concluded that the five fatalities occurred as a result of the following:

1. The lack of hazard recognition.

2. The failure to lower the grain augers to the horizontal position before moving them to other locations.

RECOMMENDATIONS

NIOSH recommends that all farm owners/managers, farm/agricultural workers, and farm equipment manufacturers be made familiar with, and reinforce the following steps:

1. Hazard Awareness

A survey of the farm should be conducted to identify hazards posed by the locations of overhead electrical lines. When all such hazards are identified and documented for future reference, workers should be informed of their location and instructed in the steps necessary to safely move grain augers.

2. Safe Movement of Grain Augers and Other Farm Equipment

Grain augers pose a life threatening hazard when moved in an elevated position if they contact overhead electrical lines or if they tip over. Therefore, it is essential that grain augers be lowered to a horizontal position before being moved from one location to another. In addition, all other equipment to be moved should be evaluated in order to determine the most appropriate method that will ensure worker safety during its transport. Manufacturers of grain augers are urged to consider design modifications that will prevent grain augers from being moved while in an elevated position.

3. **Safety Signs**

It is recommended that users and manufacturers of grain augers affix safety signs onto the equipment that warn the user of the potential hazards of moving the auger in its upright position. A safety sign to draw attention to avoiding electrical hazards when moving grain augers is provided with this Alert.** This sign should be placed on the grain auger in a conspicuous location so that it will alert workers of life threatening hazards.

We are requesting editors of appropriate trade and farm journals, members of farm extension associations, and those responsible for safety and health (e.g. inspectors, managers, and agricultural extension specialists) to bring these recommendations to the attention of farm workers, managers, and owners.

Requests for additional information on control practices or questions related to this announcement should be directed to Mr. John B. Moran, Director, Division of Safety Research, National Institute for Occupational Safety and Health, 944 Chestnut Ridge Road, Morgantown, West Virginia 26505, Telephone (304) 291-4595.

We greatly appreciate your assistance.

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**A single copy of this safety sign is available from the address given on page ii.

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Request for Assistance in

Preventing Fatalities Due to Fires and Explosions in Oxygen – Limiting Silos

July 1986

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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REQUEST FOR ASSISTANCE IN PREVENTING FATALITIES DUE TO FIRES AND EXPLOSIONS IN OXYGEN-LIMITING SILOS

WARNING!

FIRE DEPARTMENTS RESPONDING TO INCIDENTS INVOLVING OXYGEN-LIMITING SILOS ARE CAUTIONED THAT DIRECTING WATER OR FOAM ONTO THE FIRE THROUGH THE TOP OPENINGS OF AN OXYGEN-LIMITING SILO MAY RESULT IN THE SILO EXPLODING.

SUMMARY

This Alert requests the assistance of fire department personnel, farm owners and workers, and silo manufacturers in the prevention of fatalities due to fires and explosions occurring in oxygen-limiting silos.

Several recent incidents occurred while fighting oxygen-limiting silo fires which resulted in the death of fire fighters. Other fire fighters lost their lives as a result of similar explosions in the late 1960's. The problems associated with burning silos appeared to have abated during recent years, but these incidents demonstrate the need to renew efforts to minimize their recurrence. A concerted effort should be made to prevent silo fires from occurring and to provide training programs on controlling this type of fire.

July 1986

BACKGROUND

Oxygen-limiting silos by design have all their openings sealed to prevent oxygen from entering the silo. Generally, these silos are of steel or concrete construction of varying heights and diameters. The openings (bottom and top) are normally sealed with rubber-gasketed hatches. When these hatches are tightly closed and the silo is filled, the oxygen concentration should be insufficient to support a fire. If the hatches are left open or the oxygen-limiting features are not properly maintained, spontaneous heating can occur with subsequent ignition of the silage [1].

If improperly sealed or otherwise not operating as designed, the amount of oxygen entering the silo may be sufficient to allow a fire to smolder, causing an accumulation of combustible gases due to incomplete combustion. Any additional increase in oxygen content in such an environment can create an explosive atmosphere. Thus, merely opening the top hatches of such silos, or applying water or foam by hose stream from the top of the silo, could allow sufficient oxygen to enter the silo and create an explosive atmosphere [1-4]. Dust explosions may also occur if dust inside the silo becomes suspended as a result of the hose stream, and is ignited by the heat of the smoldering fire [3,5].

CASE REPORT OF A FATAL INCIDENT

The following case report resulted from a NIOSH investigation of the circumstances of the incident as part of the NIOSH Fatal Accident Circumstances and Epidemiology Program.

On August 27, 1985, three fire fighters were killed when a burning oxygen-limiting silo exploded. The fire fighters were spraying water onto the fire from the top of the silo at the time of the explosion. The explosion lifted the concrete roof of the silo approximately four feet in the air and the fire fighters were thrown from the silo.

This explosion was due either to a build up of combustible gases from incomplete combustion or a dust explosion, or a combination of the two. Regardless of the ultimate cause of the explosion, directing water into the top of the silo appears to have been an improper method for fighting this silo fire.

In this incident nothing should have been done to increase the level of oxygen inside the silo. Opening the top hatches to apply water to the fire could have increased the level of oxygen and created an explosive atmosphere. Air entrained in the water stream may have also contributed. Additionally, the water spray could have suspended the dust and increased the risk of explosion.

NIOSH is aware of three other explosions that occurred in oxygen-limiting silos at about the same time as the incident described in the case report. Two of the incidences occurred in the same geographical area as the incident described above. No fire fighters were applying water to these silos at the time, and there were no injuries. The third fire which occurred in another geographical area resulted in the fatal injury of one fire fighter [4].

REGULATORY STATUS

There are no specific OSHA regulations covering fire hazards of oxygen-limiting silos. Also, since most farms employ less than ten workers, other general OSHA regulations that might apply are not used. Therefore, OSHA estimates that over 90% of all farms in the U.S. are not covered by any OSHA regulations.

RECOMMENDATIONS FOR ACCIDENT PREVENTION

A. Basis for Needed Actions

The information collected in this case study suggests that the following factors may have contributed to the fatal accident as reported:

1. Improper fire fighting methods; and

2. Lack of proper operating and maintenance procedures on the silo.

B. Recommended Measures

Acknowledging concern for the above factors, NIOSH recommends the following steps for both the prevention of fires and explosions in oxygen-limiting silos, and for fire control procedures once a fire has developed:

1. Prevention

a. When not being filled or emptied, oxygen-limiting silo hatches should be **kept closed**. If an oxygen-limiting silo is properly sealed, there is very little likelihood of a fire occurring by spontaneous heating, since the amount of oxygen trapped in the silo is usually insufficient to support a fire.

b. Proper maintenance of the silo should be performed to ensure the integrity of the oxygen-limiting features. The manufacturer of the silo should be contacted for proper operating and maintenance procedures for the silo.

c. The moisture content of stored silage should be controlled, as should the type of cut of the silage. Filling rates recommended by the manufacturer should also be followed to reduce the possibility of spontaneous heating of stored silage. "Elements of good silage" can be obtained from the bulletin, "Extinguishing Silo Fires," NRAES-18, published by the Northeast Regional Agricultural Engineering Service, Cornell University, Riley Robb Hall, Ithaca, New York 14853.

2. **Fire Control**

a. During fire fighting operations on oxygen-limiting silos, water or foam should not be directed onto the fire through the top hatches, since this may allow oxygen to enter the silo and cause the suspension of explosive dust.

b. Placards should be placed on the oxygen-limiting silos warning fire fighters that the silo is in fact an oxygen-limiting silo, and should include information concerning the proper extinguishing techniques.

c. If the roof hatches of oxygen-limiting silos are open, no attempt should be made to close them if there is smoke or steam coming from the open hatches or if the silo is vibrating.

d. The roof hatches should be safe to close if the silo is quiet and there has been no smoke or steam coming from the hatches for several hours. Do not secure the hatch. This will permit the relief of any subsequent pressure that may build up.

e. Large quantities* of carbon dioxide or liquid nitrogen should be injected into the silo to extinguish the fire. Some silos have valves specifically designed for this. If it is necessary to drill a small hole in the side of the silo for insertion of the gas tube, care should be taken not to allow additional oxygen to be pulled into the silo. All precautions normally associated with either nitrogen or carbon dioxide should be taken when handling these gases.

*Note: As an example, for a 20-foot diameter by 60-foot-high silo, the estimated amount of carbon dioxide or liquid nitrogen would be: 20 standard cylinders of carbon dioxide or 40 standard cylinders of liquid nitrogen. Reference #1 provides estimated amounts of CO_2 or liquid nitrogen for other silo sizes.

f. Manufacturers, in conjunction with local fire departments, should establish a program to provide valves designed for injection of gases for fire control on all new and existing oxygen-limiting silos.

g. Certain manufacturers have step-by-step instructions on how to extinguish fires in their silos. Therefore, farm owners are encouraged to contact the silo manufacturer to obtain these instructions.

NIOSH has published the following documents which contain further information:

NIOSH Alert: Request for Assistance in Preventing Hazards in the Use of Water Spray (Fog) Streams to Prevent or Control Ignition of Flammable Atmospheres, DHHS (NIOSH) Publication No. 85-112.

Occupational Safety in Grain Elevators and Feed Mills, DHHS (NIOSH) Publication No. 83-126.

NIOSH requests that the technical information and warning contained in this Alert be disseminated to personnel of fire departments, fire training academies, other emergency response organizations, farm extension associations, farm workers and owners, and manufacturers of silos.

Requests for additional information or questions related to this announcement should be directed to Mr. John Moran, Director, Division of Safety Research, National Institute for Occupational Safety and Health, 944 Chestnut Ridge Road, Morgantown, West Virginia 26505, Telephone (304) 291-4595.

We greatly appreciate your assistance.

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REFERENCES

1. Murphy DJ, Arble WC: Extinguishing Silo Fires. NRAES-18. Ithaca, NY: Northeast Regional Agricultural Engineering Service (1982).

2. NIOSH Alert: Request for Assistance in Preventing Hazards in the Use of Water Spray (Fog) Streams to Prevent or Control Ignition of Flammable Atmospheres, DHHS (NIOSH) Publication No. 85-112. National Institute for Occupational Safety and Health, 4 pages (1985).

3. Bahme CW: Fire Officer's Guide to Emergency Action. NFPA No. FSP-38. Boston, MA: National Fire Protection Association, 185 pp. (1974).

4. Upgrade Training Programs Aimed at Controlling Silo Explosions, Say National Volunteers. Fire Control Digest, 12(2):6 (1986).

5. Occupational Safety in Grain Elevators and Feed Mills, DHHS (NIOSH) Publication No. 83-126. National Institute for Occupational Safety and Health, 85 pp. (1983).

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Request for Assistance in

Preventing Electrocutions Due to Damaged Receptacles and Connectors

October 1986

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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REQUEST FOR ASSISTANCE IN PREVENTING ELECTROCUTIONS DUE TO DAMAGED RECEPTACLES AND CONNECTORS

WARNING!

PERSONS USING ELECTRICAL EQUIPMENT ARE CAUTIONED THAT THE USE OF DAMAGED RECEPTACLES AND CONNECTORS CAN BE EXTREMELY DANGEROUS.

SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) is requesting assistance in preventing the electrocution of workers due to the use of damaged electrical receptacles and connectors. Two recent incidents are described. Results of the investigations indicate that **periodic inspection**, **recognition of hazards**, and **proper use of receptacles and connectors**, and **prompt repair of damaged connectors and receptacles**, could prevent such incidents. Editors of appropriate trade journals, safety and health officials, and especially those who work with electrical equipment, are requested to bring these recommendations to the attention of owners, managers, and workers.

October 1986

BACKGROUND

Occupational electrocutions continue to be a serious problem throughout the United States. Data obtained from the Bureau of Labor Statistics' Annual Survey indicate that approximately 10% of all occupational fatalities are due to electrocutions. Those data, as well as other information collected by the National Institute for Occupational Safety and Health (NIOSH), demonstrate that fatalities due to electrocutions occur in a variety of ways. For example, previous NIOSH Alerts have described cases in which workers have been electrocuted as a result of contacting improperly grounded equipment, or when cranes or grain augers have contacted overhead power lines [1,2]. This Alert presents information on two fatal electrocutions that occurred as a result of using damaged receptacles and connectors.

Two investigations by NIOSH found evidence to suggest that the victims were unaware of hazards associated with the use of damaged connectors. In both cases, it was assumed that because a connector fit into a receptacle, the connection was proper and no hazard existed. The prevalence of this particular hazard is not clear. However, the cases described below point out the insidious nature of this hazard. The presence of receptacles and connectors in all workplaces, and the repetitive nature of their use (which in certain workplaces increases the possibility of damage) suggests that the potential hazard is widespread. These investigations also demonstrate that careful routine inspection and aggressive maintenance might well prevent such fatalities.

CASE REPORTS OF FATAL INCIDENTS

Case #1 - (ONE FATALITY)

On July 23, 1985, a 24-year-old employee of a textile mill was electrocuted when he touched a loom frame while performing his routine duties at the loom. The loom had become energized when an electrical, three-prong connector from a thread feeder machine was inserted into a damaged receptacle mounted on the loom. The damage to the receptacle permitted the ground prong of the plug to be improperly inserted into one of the phase terminals (90 degrees clockwise away from the appropriate ground terminal). This resulted in energizing the ground prong and the frame of the loom. When the worker touched the energized loom, he was electrocuted. It appeared, upon subsequent inspection, that the receptacle had been damaged because of a lack of adequate strain relief for the electrical cord from the thread feeder.

Case #2 - (ONE FATALITY)

On July 29, 1985, a 29-year-old welder was electrocuted when he inserted the "male" end of an electrical plug on a portable arc welder into a broken "female" connector of an extension cord. As in the previous case, the victim inserted the ground prong of the welder cord 90 degrees clockwise away from the appropriate ground terminal of the extension cord, and the metal casing of the welder connector became energized. It appeared that the connector on the extension cord had been damaged by everyday use or abuse (being thrown down on and dragged across concrete floors, being run over by industrial equipment, etc.).

REGULATORY STATUS

Although, in these investigations the receptacles and connectors in these investigations were listed by a nationally recognized testing laboratory, the damaged state of the receptacles negated their conformance to these listings*, to the manufacturers' specifications, and to the safety features inherent in their design. NIOSH strongly urges periodic inspection and maintenance of electrical systems to assure compliance with applicable sections of the National Electric Code, OSHA standards, and other listing requirements. Electrical components should be used only in accordance with the manufacturers' specifications, and should be tested and approved by a nationally recognized laboratory (such as Underwriters Laboratory, Factory Mutual, etc.).

CONCLUSION

The investigations by NIOSH indicate that damaged receptacles may physically permit improper electrical connections to be made, negating the intended safeguards designed into them. Furthermore, workers may not recognize a hazard of electrocution associated with the use of worn or damaged receptacles and connectors. Electrical hazards of this sort are of particular concern because of the large number of users of electrical equipment in all kinds of workplaces. Investigations of such incidents suggest failures in the areas of **PROPER UTILIZATION OF ELECTRICAL COMPONENTS**, **HAZARD RECOGNITION**, and **PERIODIC INSPECTION AND MAINTENANCE OF ELECTRICAL SYSTEMS**. These basic safety activities are potentially lifesaving in preventing such incidents.

Caution should be used around **ALL** electrical circuits and equipment. The potential for electric shock should never be underestimated. Employers and other groups should regularly emphasize the safe use of electricity in the workplace. Continuous efforts must be made to prevent electrical injuries and deaths due to damaged receptacles and connectors.

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*A listing means that the piece of equipment has met the safety criteria established by the testing laboratory.

RECOMMENDATIONS

NIOSH makes the following recommendations in these areas:

1. **PROPER UTILIZATION OF ELECTRICAL SYSTEMS**

All receptacles and connectors should be used only in accordance with the manufacturers' specifications, and the specific listing for the item as set forth by nationally recognized testing laboratories. Users should be advised of the importance of using receptacles and connectors only for applications for which they have been designed. When a component is selected for use, it should be evaluated to determine if it can tolerate the environment to which it will be exposed. Physical abuse and stress on these components should be minimized by the selection of a safe location and by the use of stress/strain relief devices.

2. **AWARENESS AND RECOGNITION OF HAZARDS**

Policies that address the proper use of receptacles and connectors should be developed and implemented by qualified safety personnel. Safety training should emphasize awareness and recognition of electrical hazards associated with receptacles and connectors (i.e., broken receptacles and connectors, improper electrical connections, damaged cords, the importance of grounding, etc.). Immediate corrective action should be taken when damaged components or safety hazards are encountered. When safety policies and procedures are developed, they should be enforced.

3. **PERIODIC INSPECTION AND MAINTENANCE OF ELECTRICAL SYSTEMS**

Periodic inspections should be conducted for all electrical system equipment and components in order to identify all electrical hazards present. Records should be kept of any electrical hazards identified, and appropriate corrective action should be taken immediately These periodic inspections should be supplemented with daily inspections by the personnel using this equipment.

We urge safety and trade associations interested in job site safety to bring these recommendations to the attention of employers.

Requests for additional information, and comments or questions concerning this announcement, should be directed to Mr. John Moran, Director, Division of Safety Research, National Institute for Occupational Safety and Health, 944 Chestnut Ridge Road, Morgantown, West Virginia 26505, Telephone (304) 291-4595.

We greatly appreciate your assistance.

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REFERENCES

1. NIOSH Alert: Request for Assistance in Preventing Electrocution from Contact Between Cranes and Power Lines. DHHS (NIOSH) Publication No. 85-111, National Institute for Occupational Safety and Health, 6 pages (1985).

2. NIOSH Alert: Request for Assistance in Preventing Grain Auger Electrocutions. DHHS (NIOSH) Publication No. 86-119, National Institute for Occupational Safety and Health, 4 pages (1986).

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Request for Assistance in

Preventing Fatalities of Workers Who Contact Electrical Energy

December 1986

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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REQUEST FOR ASSISTANCE IN PREVENTING FATALITIES OF WORKERS WHO CONTACT ELECTRICAL ENERGY

ATTENTION!

PROMPT EMERGENCY MEDICAL CARE CAN BE LIFESAVING FOR WORKERS WHO HAVE CONTACTED EITHER LOW VOLTAGE OR HIGH VOLTAGE ELECTRICAL ENERGY. IMMEDIATE CARDIOPULMONARY RESUSCITATION (CPR) FOLLOWED BY ADVANCED CARDIAC LIFE SUPPORT (ACLS) HAS BEEN SHOWN TO SAVE LIVES.

SUMMARY

Recent incidents that have come to the attention of NIOSH have shown that electrocution victims can be revived if immediate cardiopulmonary resuscitation (CPR) or defibrillation is provided. While immediate defibrillation would be ideal, CPR given within approximately 4 minutes of the electrocution, followed by advanced cardiac life support (ACLS) measures within approximately 8 minutes, can be lifesaving. This alert describes recommendations that can be used to help save the lives of workers who contact electrical energy. Editors of appropriate trade journals, safety and health officials, and especially those who work with electrical equipment, are requested to bring these recommendations to the attention of owners, managers, and workers.

December 1986

BACKGROUND

It has been estimated that at least 700 occupational electrocutions occur each year [1]. Therefore, a primary goal of occupational safety programs must be to prevent workers from contacting electrical energy. Effective measures include safe work practices, job training, proper tools, protective equipment, and lockout/tag-out procedures.

Investigations by NIOSH, as part of its Fatal Accident Circumstances and Epidemiology (FACE) Project, also have revealed that once an electrical energy incident occurs, emergency response plans are often lacking, even in organizations which promote safety. Hence, a secondary goal of safety programs must be to provide appropriate emergency medical care to workers who contact electrical energy.

The National Electrical Code divides voltages into two categories: greater than 600 volts (high voltage) and less than or equal to 600 volts (low voltage) [2]. Momentary contact with low voltages produces no thermal injury, but may cause ventricular fibrillation (very rapid, ineffective, heartbeat) [3].

In contacts with high voltage, massive current flows may stop the heart completely. When the circuit breaks, the heart may start beating normally [3]. Supporting respiration by immediate mouth-to-mouth techniques may be required, even if heartbeat and pulse are present. If extensive burns are present, death may result from subsequent complications [4].

APPROPRIATE STANDARDS AND GUIDELINES

The revised "Standards and Guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC)" published in June 1986, is a product of the 1985 National Conference on CPR and ECC. There are two parts: basic cardiopulmonary resuscitation (CPR) and advanced cardiac life support (ACLS). A lay person can be trained in CPR to support circulation and ventilation of the victim of cardiac or respiratory arrest, until ACLS (provided by medical professionals using special equipment) can restore normal heart and ventilatory action [5].

Speed has been found to be critical to resuscitation: immediate defibrillation would be ideal. The highest success rate has been achieved in those patients for whom CPR followed cardiac arrest within approximately 4 minutes, and ACLS was begun within approximately 8 minutes of the arrest [5]. CPR often must be initiated immediately by lay individuals at the scene of the incident. It should be noted that CPR skills can be gained in 4-hour courses similar to those taught by the American Heart Association or the American Red Cross.

NIOSH CASE REPORTS

Case #1 - SUCCESSFUL RESUSCITATION

A 30-year-old construction worker was working on a fire escape in a building being renovated. Another worker handed the victim a metal pipe, and he was holding it with both hands when it contacted a nearby high voltage line, completing a path-to-ground. The worker instantly collapsed from this contact with electrical energy. Approximately 4 minutes after he collapsed, the fire department rescue squad arrived and began CPR. Within 6 minutes, a paramedic unit was on the scene providing defibrillation and other ACLS measures. They were able to establish a heartbeat and pulse, but the individual continued to require respiratory support during transport to the hospital. He regained consciousness and was discharged within two weeks. He did have to return for further medical care for burns he received on his hands (current entrance) and buttocks (current exit) [6].

Case #2 - UNSUCCESSFUL RESUSCITATION

An 18-year-old male restaurant worker contacted electrical energy when he kneeled to plug a portable electric toaster into a 110-120 V/20 amp floor outlet. After a scream was heard, the victim was found convulsing on the damp floor, with one hand on the plug and the other on the receptacle box. The assistant manager went to the electrical panel, but was unable to locate the appropriate circuit breaker. A coworker attempting to take the victim's pulse received an electrical shock, but was not injured. After telephoning the emergency medical service, the assistant manager returned to the panel and de-energized all of the circuits (3 to 8 minutes after the worker contacted electrical energy). The injured worker was covered with a coat to "keep him warm." After about 5 minutes, another call was placed to the emergency squad, and the assistant manager "yelled" for an off-duty employee who lived in an apartment across the lot, who came and began CPR. The emergency service was on the scene 10 minutes after receiving the first call. ACLS measures were available, but the resuscitation was unsuccessful and the worker was pronounced "dead on arrival" at the local hospital. The exact time span between the worker contacting electrical energy and the beginning of CPR is unknown, but it is reasonable to assume that it was longer than 4 to 6 minutes. Paramedics with ACLS capability arrived 10 minutes after receiving the call, but more than 10 minutes after the accident occurred [7].

CONCLUSIONS

In Case #1, basic life support was begun within 4 minutes by the fire department rescue squad who happened to be stationed nearby. They were experienced and had up-to-date knowledge in CPR techniques. In this case, CPR was begun within the 4-minute recommendation. An ambulance, equipped and staffed to provide ACLS, arrived within 6 minutes. The standards and guidelines [5] for CPR within 4 minutes, and ACLS within 8 minutes, were met and the worker did survive.

In Case #2, the worker's contact with electrical energy was prolonged and a coworker who aided him received an electrical shock, because coworkers did not know how to de-energize the circuit. The optimal times for CPR and ACLS were exceeded, and the resuscitation was unsuccessful. Providing appropriate medical care after an electrical energy incident will not guarantee success. However, as has been reported elsewhere [5] and supported in the NIOSH case reports, the chance for successful resuscitation after cardiopulmonary arrest is best when the criteria for providing emergency medical care are met.

RECOMMENDATIONS

1. PREVENTION

PREVENTION must be the primary goal of any occupational safety program. However, since contact with electrical energy occurs even in facilities which promote safety, safety programs should provide for an appropriate emergency medical response.

2. SAFE WORK PRACTICES

No one who works with electrical energy should work alone, and in many instances, a "buddy system" should be established. It may be advisable to have both members of the buddy system trained in CPR, as one cannot predict which will contact electrical energy.

Every individual who works with or around electrical energy should be familiar with emergency procedures. This should include knowing how to de-energize the electrical system before rescuing or beginning resuscitation on a worker who remains in contact with an electrical energy source.

All workers exposed to electrical hazards should be made aware that even "low" voltage circuits can be fatal, and that prompt emergency medical care can be lifesaving.

3. CPR AND ACLS PROCEDURES

CARDIOPULMONARY RESUSCITATION (CPR) and first aid should be immediately available at every worksite. This capability is necessary to provide prompt (within 4 minutes) care for victims of cardiac or respiratory arrest, from any cause.

Employers may contact the local office of the American Heart Association, the American Red Cross, or equivalent groups or agencies, to set up a course for employees.

Provision should be worked out at each worksite to provide **ADVANCED CARDIAC LIFE SUPPORT (ACLS)** within 8 minutes (if possible), usually by calling an ambulance staffed by paramedics. Signs on or near phones should give the correct emergency number for the area, and workers should be educated regarding the information to give when the call is made. For large facilities, a prearranged place should be established for company personnel to meet paramedics in an emergency.

We are requesting that employers, worker representatives, editors of appropriate trade journals, and safety and health professionals assist in disseminating these recommendations to those individuals and organizations responsible for providing a safe workplace. Suggestions or questions related to this announcement should be directed to Mr. John Moran, Director, Division of Safety Research, National Institute for Occupational Safety and Health, 944 Chestnut Ridge Road, Morgantown, West Virginia 26505-2888, telephone (304) 291-4595.

We greatly appreciate your assistance.

J. Donald Millar, M.D., D.T.P.H. (Lond.)
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☆ U.S. GOVERNMENT PRINTING OFFICE: 1987 - 748-122/60534

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