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Industrial Hygiene Survey Report
of
MILLSTONE NUCLEAR POWER STATION NO. 3 CONSTRUCTION SITE
(Northeast Utilities Service Co./Stone and Webster Engineering Corp.)
Waterford, Connecticut

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DATE OF SURVEY:
March 3-5, 1981

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Personal and area air samples were analyzed for total dust, organic solvent vapors, and metals during spray, brush, and roller painting and paint removal operations (SIC-1629) at Millstone Nuclear Power Station Number 3 construction site, Waterford, Connecticut, March 1981. Solvent exposures were generally well below their relevant standards. Total dust exposures during paint removal ranged up to 1,000 milligrams per cubic meter (mg/m3) in the containment building. The OSHA standard for total dust is 15mg/m3. Exposures to lead (7439921) dusts exceeded the OSHA standard of 0.05mg/m3 in the turbine, auxiliary, and containment buildings. Chromium (7440473) exposures were generally below the OSHA standard of 1mg/m3, except for 2.4mg/m3 in a personal sample taken during paint removal in the containment building. Very few engineering controls other than 3M single use respirators were observed. The authors note that the chromium exposure data is difficult to interpret as the form of the chromium is not known. If the chromium existed as hexavalent chromium, exposure was excessive. The authors conclude that in view of the measured exposures to total dust, lead, and chromium, engineering controls and respiratory protection are inadequate Recommendations include implementing better controls and respiratory protection

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PURPOSE:	To conduct an in-depth industrial hygiene survey to determine exposures of painters to coating components during the construction of a nuclear power plant. This survey was conducted as part of the Industrywide Studies Branch survey of Health Hazards in the Painting Trades.
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STANDARD INDUSTRIAL CLASSIFICATION:	1629: Heavy Construction, Not Elsewhere Classified

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DISCLAIMER

Mention of company names or products in this report does not constitute endorsement by the National Institute for Occupatonal Safety and Health.

ABSTRACT

The Industrywide Studies Branch, Industrial Hygiene Section conducted an in-depth industrial hygiene survey of painting and allied construction processes at the Millstone Nuclear Power Station #3, Waterford, Connecticut, on March 3-5, 1981. The survey was one of six in-depth surveys of industrial painting operations performed as part of the Industrywide Studies Branch (IWSB) study of health hazards in the painting trades. The survey was performed to characterize the exposures of painters to the components of the coating materials used.

Painters' exposures to individual organic solvents were generally well within the current OSHA PEL's, NIOSH recommended standards, or ACGIH Threshold Limit Values (TLV's). The highest additive exposure to a mixture of solvents (0.78 in the ESF Building) also was not excessive with respect to current TLVs.

Spray painters working in the ESF Building were exposed to airborne concentrations of 2-ethoxyethanol ranging from 14 to 72 mg/m^3 . The highest eight hour, time weighted, average exposure ($72mg/m^3$) was approximately 40% of the current TLV ($185 mg/m^3$). The geometric mean, eight-hour personal exposure in this area, however, was 33 mg/m^3, approximately 18% of the TLV. NIOSH currently recommends that exposure to 2-ethoxyethanol (and its acetate ester) be reduced to the extent possible.

Exposures of personnel to total dust and lead during paint removal with power brushes in the Turbine, Auxilliary, and Containment Buildings were frequently in excess of current OSHA PELs, ACGIH TLVs, and NIOSH recommendations for these contaminants. If the total chromium measured in these samples was insoluble hexavalent chromium (e.g. present as lead or zinc chromate), these personnel were also frequently exposed to Chromium (VI) in excess of the NIOSH recommended standard of 0.001 mg/m^3, as well as the ACGIH TLV for "certain water insoluble Chromium (VI) compounds" of 0.05 mg/m^3. This conclusion seems likely to be correct, since the application in question (corrosion protection of steel surfaces) suggests the use of zinc or lead chromate, which are frequently used as pigments in primers designed for protection against corrosion. One painter (during removal of old paint in the containment building) was also exposed to total chromium (2.4 mg/m^3) in excess of the OSHA PEL of 1 mg/m^3.

General recommendations were made to improve control of dust generation, respiratory protection, and work practices during power brush removal of paint.

INTRODUCTION

Background

The Industrywide Studies Branch (IWSB),Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS), NIOSH, initiated in 1978 a study of health hazards in the painting trades. The study was prompted by the results of a 1975 NIOSH pilot study (conducted under contract by the Mt. Sinai School of Medicine, NY, NY), and by the results of a number of literature reports, which indicated that central nervous system, pulmonary, and other effects were occurring in "painters" with some regularity, particularly in epoxy painters (1-5).

In late 1977, a contract was awarded to The John Hopkins University, School of Hygiene and Public Health, to begin industrial hygiene, and if necessary, epidemiological and/or medical studies of workers engaged in painting activities in industrial or commercial settings. In 1978 through 1980, fifty walk-through surveys were conducted in ten different major industries. In the Construction and Maintenance industry, five such surveys were conducted. The purpose of the surveys was to determine if any of the sites visited would be suitable for inclusion in in-depth industrial hygiene, epidemiological, or medical studies. This site was selected (from among other active construction sites) for further industrial hygiene assessment in part because of the extensive use of epoxy paints.

This report summarizes the results of the in-depth industrial hygiene survey conducted at the Millstone Nuclear Power Station #3, located in Waterford, Connecticut, March 3-5, 1981. The station is under construction by the Stone and Webster Engineering Corporation for the Northeast Utilities Service Co.

Authority

Studies of this nature are authorized under the Occupational Safety and Health Act of 1970, Public Law 91-596, December 29, 1970. NIOSH has been designated responsibility for conducting field research studies in industry, to evaluate findings, and report on these findings. Section 20(a)7 states that NIOSH shall publish industry wide studies of the effects of chronic or low level exposure to industrial materials, processes, and stresses on the potential for illness, disease, or loss of functional capacity.

PLANT DESCRIPTION

Stone and Webster Engineering Company is the design and construction manager for the Millstone Nuclear Power station #3. The nominal 1150 MW plant, located near Waterford, Connecticut, is being built for Northeast Utilities Service Company (NUSCO). It is the third of three nuclear power stations located on the same site. The other two plants were completed previously. Construction of Station #3 was begun in 1974, and is expected to be completed in 1986.

Appendix A, Figure 1, is a simplified plot diagram of the site and the major buildings. The four major areas surveyed were the Turbine, Reactor Containment, Auxilliary, and the Engineered Safety Features (ESF) Buildings, and the Paint Shop. Other major buildings on the site, not surveyed (since no painting activities were underway at the time of the survey), include the Main Steam Valve Building (MSVB), the Office, Control, Service, Waste Disposal, and Fuel Buildings, the Pump House, and numerous other smaller structures and buildings.

WORKFORCE AND PERSONNEL RECORDS DESCRIPTION

At the time of this evaluation, (March, 1981), the Stone & Webster Engineering Corporation employed 1,351 persons at the Millstone #3 Plant Construction Site. Of these, 997 were hourly employees (59 female), and 354 were salaried (10 female). There were 31 employees classified as spray painters, who were the primary focus of the survey. Also evaluated were two sub-grcups of employees, paint mixers and power brushers, who also were potentially exposed to paints or paint components.

The painters at this facility were primarily members of the International Brotherhood of Painters and Allied Trades. Many also worked on the construction of the Millstone #1 and #2 sites adjacent to the current construction site. The precise number of painters varied daily according to the amount of painting required. The painters worked a single shift, staggered between the usual shift of other workers, from 12 noon to 7:30pm.

Painters were hired directly from the union hall (IBPAT Local #1122) by Stone and Webster Engineering Corp. While the site was being constructed, Stone & Webster kept a computer printout of all of the persons employed and paid at this facility. The computerized system indicated the total number of employees working at each site, and the number working at each workplace within the site, but it did not identify individual employees.

In addition, while still working at the site, three or four possible cards were kept on the person. An employment slip recorded his/her date of birth, sex, citizenship, number of dependents, marital status, name, address, social security number, and employee number. A foreman workcard also recorded where a painter was working and the type of paint applied during the time of his work. At the completion of the job these cards were discarded.

The cards included no record of previous employment except when the person claimed special painting qualifications. In order to paint in the nuclear containment area, the person was required to demonstrate proficiency in paint application. If a person changed jobs while working at this site he was given a change of rate slip which indicated the new job assignment. Thus, during the power plant construction period, it is possible to identify a person's total work experience, and the type of paint used by each employee.

INDUSTRIAL HYGIENE, MEDICAL, AND SAFETY PROGRAMS

Stone & Webster had no formal industrial hygiene program at this site, although some industrial hygiene studies were performed by consultants or by Northeast Utility's insurance carrier. No evaluations had been conducted of paint-related operations.

Medical facilities consisted of a first aid station maintained at the site. The station was attended by a nurse during the regular day shift only. Two first aid technicians were assigned to the site during each of the other shifts. A local physician visited the site once a week. No pre-employment physicals were conducted at this site. However, each hire filled out a previous medical history questionnaire which was kept on file in the first aid station and time office until the job ended.

Stone & Webster's safety program was managed by the Senior Safety Supervisor. The program included weekly "tool box" safety meetings with all employees, as well as quarterly safety meetings with union stewards and foremen from each area at the site.

A written respiratory protection program had been developed for the site, which specified required equipment for specific jobs, and provided for training of painters (and other employees required to wear respirators) in the use and maintenance of the equipment. A log was kept of respirator and cartridge issue as well as respirator use.

Positive pressure, air supplied respirators were required when paint was applied in a confined space, epoxy paint was being applied, or spray equipment was used. In other types of painting jobs, half facepiece, negative pressure cartridge respirators (typically Willson 12119, or equivalent) were required. During paint removal operations with power brushes, single use, disposable dust respirators (typically 3M Co. No. 8710) were used.

PAINTING OPERATIONS AND ENGINEERING CONTROLS

During this survey, painting operations were conducted in the paint shop, and in the Containment, Auxilliary, Turbine, and ESF Buildings. Although most painting was done with brush or roller, compressed air spray was used occasionally for large surfaces. Most paint was applied directly at the work site, in rooms consisting either of large open spaces, or smaller rooms treated essentially as confined spaces.

Depending on the method of paint application and the circumstances of application, one to three gallons per day could be applied by each painter. During compressed air spray application, twenty to thirty gallons per day could be applied. In general, painting was conducted during periods when other trades were not working or in isolated areas, or the area was quarantined and posted.

All surfaces which will potentially come in contact with radioactive materials are required by federal regulations to be painted with epoxy paints. Thus, in the Containment, ESF, and Auxiliary buildings, the walls, floors (mostly concrete surfaces), ceilings, and all external surfaces of steel structures (pipes, beams, support structures, etc.) were coated with epoxy paint. All of the epoxy paint used at this site was supplied by Keeler and Long of Watertown, Connecticut. A single coat of primer (K&L #6548 Epoxy White Enamel) and two or three coats of topcoat (K&L #E-1-7475 Epoxy White Enamel) were normally used. These are both two-part epoxies.

Whereas epoxies were used exclusively where there was any possibility of radioactive contamination, alkyd or silicone-alkyd paints were used extensively in areas where contamination was not possible. In the Turbine Building, which is the largest of the non-nuclear areas, K&L Tri-Polar™ White Primer #6040, and Tri-Polar Silicone Enamel were used primarily on structural steel, machinery, or tanks. Also used to a lesser extent on non-structural surfaces (e.g. interior masonry walls, ceilings), were vinyl acrylic resin based paints, and a variety of other specialized types such as an inorganic zinc based primer (e.g. K&L #6500 Galv-Anode Primer™, Ameron co.™ dimetcote #6), and epoxy filler compounds used to seal poured concrete surfaces and concrete block (e.g. Ameron Co. NU-KLAD 114™).

Some pieces of equipment and parts (primarily pipe) were painted prior to installation. These parts were coated at the paint shop on site. Before painting, pipes were abrasive blasted with Black Beauty by painters wearing air supplied hoods. Pipes and other pieces were painted with brush, roller, or spray gun. Spray painting was done in a large walk-in booth (approximately 38W'x10D'x9H') exhausted by twin, tube-axial fans (each rated at 26,800 design CFM) powered by explosion proof motors. This booth was newly constructed, since during the earlier walk-through survey by NIOSH-IWSB (August, 1979), most pieces were painted outdoors on pipe racks (6).

The paint shop constituted a base of operation for active painters. For example, painters used the mixing equipment to mix or thin paints prior to carrying them to the actual work site. At the time of the survey, only one person was assigned to work at the paint shop full-time. This person was responsible for painting operations conducted at the shop, for paint shop equipment maintenance, and for distributing paint and supplies as needed throughout the construction site.

Table 1 lists the major painting-related activities conducted during the survey, and lists the major types of paints, cleaners, and thinners used. In addition to the painting activities, removal of paint from various types of structures (mainly the external surfaces of steel tanks, nuts, bolts, etc.), was done in the Turbine, Auxiliary, and Containment Buildings. In general, the paint was removed using hand held, electrically operated power brushes. The types and compositions of coatings being removed were unknown.

Table 1
Summary of Painting Activities and Exposure Evaluations
Millstone Nuclear Power Plant #3
March 3-5, 1985

Activity	Paint Shop	Turbine Building	Auxiliary Building	Containment Bldg.	ESF Bldg.
Compressed Air Spray Painting	1,2	—	—	2,4,8	1,2
Power Brushing (Paint Removal)	—	5	5	5	—
Roller Painting	—	2,3	—	—	—
Brush Painting	—	2,3	2	4	—
Paint Mixing and Thinning	1,2,3, 6,7	—	—	—	2,7

Products Used:
1- Keeler & Long E-1-7475 white Epoxy Enamel
2- Keeler & Long #6548 white Epoxy Primer
3- Keeler & Long #6040 white Tri-Polar Primer
4- Dimetcote #6 Inorganic Zinc Primer
5- Old Paint; type unknown
6- Keeler & Long #1638 Thinner
7- Keeler & Long #4093 epoxy Thinner
8-Amercoat #12 cleaner

In the Engineered Safety Features (ESF) building, the walls of a basement room (approximately 44' x 20' x 8') were painted with epoxy primer and epoxy enamel. The paints were applied using hand held, compressed air spray guns by a two man crew. The two men alternated specific tasks, one of whom spray painted while the other assisted by moving the hoses, tending the pot, mixing or thinning paint, and cleaning equipment. Each man spray painted for approximately a half shift, and assisted during the other half. This was the major spray painting activity conducted during the survey, and subjectively presented the greatest potential for worker exposure to non-volatile, as well as volatile, paint components. This was due mainly to the relatively confined conditions under which the spray painting was conducted, and the method of application.

Appendix A, Figure 2, is a cutaway drawing showing the room layout, the ventilation systems in place during spraying operations in the ESF Building, and the results of some ventilation measurements conducted during the survey. Ventilation consisted of three 16-inch flexible exhaust ducts. The open ends of the ducts were located within the room as needed, and were

moved as the spray painting progressed. Each of the ducts was connected to a Coppus tube-axial fan rated at approximately 19,000 cfm. During moderate weather, natural makeup air entered through a door at each end of the room. When needed, heated makeup air was supplied with a gas-fired heater of approximately 36000 cfm capacity through a rectangular diffuser at ceiling level.

COATING COMPONENTS AND HAZARD ANALYSIS

Product Composition

Table 1 indicates the paint products used in various areas of the plant during the survey. The two epoxy based products (primer and enamel) are two-component systems which must be mixed and thinned prior to use. When mixed, both paint sytems contained epoxy resin, polyamide resin hardener (curing agent), titanium dioxide as a pigment, and a non-reactive diluent consisting of 2-ethoxyethanol (2EE), n-butyl acetate, and Solvesso 100™, a petroleum distillate blend similar to mineral spirits, consisting mainly of methyl-substituted aromatic hydrocarbons (molecular weights on the order of 120 and 134). Silica and magnesium silicate were also present in the primer as filler/thickening agents.

Laboratory analysis of samples of the epoxy-system paints (see analytical methods section), also indicated the presence of smaller amounts of xylenes and 2-ethoxyethyl acetate (2EEA). Neither system contained epichlorohydrin, bisphenol A, or low molecular weight amines, based on gas chromatographic-mass spectrometric (GC-MS) analysis of the bulk paints. K&L #4093 epoxy thinner, used to control the viscosity of the mixed paint, was found on GC-MS analysis to contain mainly xylene, n-butyl acetate, and smaller amounts of toluene and 2-EE. Similar analysis of Ameron Co. Amercoat #12™, a cleaning solvent used to clean paint lines and for general cleanup, indicated the presence of toluene, xylene isomers, and smaller amounts of methyl ethyl ketone and acetone.

K&L #6040 Tri-Polar primer is an alkyd resin based paint containing alkyd resin, titanium dioxide pigment, magnesium silicate and barium metaborate as fillers, and diluents including xylene and mineral spirits. GC-MS analysis of K&L #1638 thinner (used mainly with the alkyd and alkyd-silicone resin paints) indicated a complex mixture of C9-C12 aliphatic hydrocarbons, and some methyl-substituted aromatic hydrocarbons (e.g. trimethyl benzenes, methyl ethyl benzenes, etc.), a composition similar to mineral spirits.

Also used during the survey were anti-corrosive, inorganic zinc primers, represented by Ameron Co. Dimetcote #6™. This paint contains zinc dust (finely divided zinc metal) to provide sufficient electrical conductivity in the dried film to allow the zinc to corrode preferentially to the substrate metal (steel or iron). GC-MS analysis of the zinc primer supernatant liquid indicated the presence of o, m, and p-xylene isomers, and smaller amounts of ethanol, isopropanol, and toluene. The pigments include calcium silicate, iron oxide, and lead chromate.

Lead and chromium compounds are used as pigments in many paints. Lead and chromium, as well as iron, zinc, and manganese, were detected upon analysis of bulk dust samples obtained during paint removal operations conducted during the survey (see Methods). These metals undoubtedly were present as pigments in the paints being removed, or in the case of iron, were partially generated by abrasion of the underlying steel surfaces. It is possible, but not confirmed, that lead and/or zinc chromate were present in the paints being removed, since these are typically used in corrosion resistant primers for metal surfaces. Iron oxide is also a frequently used primer pigment.

Hazard Analysis

All of the coating materials used in the construction process are composed mainly of a resin base (epoxy, alkyd, alkyd-silicone), and pigments and fillers (titanium dioxide, magnesium silicate, silica, etc.) dissolved in various mixtures of hydrocarbons. Although many of the diluents are pure compounds (e.g. toluene, xylene, 2-ethoxethanol, etc.), some are complex mixtures of hydrocarbons, such as mineral spirits. During the abrasive removal of old paint from steel structures, the principal hazard is exposure to nuisance dust and to the metals used as pigments in the paints being removed.

Table 2 (Page 10) lists the specific materials for which evaluations were conducted during this survey. Also listed are the respective Threshold Limit Values (TLVs), published by the American Conference of Governmental Industrial Hygienists (ACGIH) Chemical Substances TLV Committee, the eight hour, time weighted, average permissible exposure limits (PELs) promulgated by the Occupational Safety and Health Administration (OSHA), and the NIOSH recommended exposure limits where applicable.

One of the major potential health hazards inherent in the process of painting is exposure to various solvents. The aliphatic hydrocarbon solvents generally are known to cause anesthesia, central nervous system depression, narcosis, and irritation of the skin. Some of the aliphatics are known to be asphyxiants (7,8). The aromatic hydrocarbon solvents are primary skin irritants. Repeated or prolonged skin contact may cause dermatitis. This is due primarily to their dehydrating and defatting properties. Central nervous system effects and carcinogenic effects are also known to occur among these solvents (7,8).

The depressant effect of most of the hydrocarbons present in the coatings used can be considered additive. This fact has been addressed by the ACGIH in the TLV publication (9), which describes the calculation of TLVs for mixtures of two or more hazardous substances having similar effects on the same organ system.

The glycol ethers are used primarily as solvents and are particularly valuable where "co-solvency" (i.e. solvency for both water and solvent based systems) is needed. Their toxic effects are attributed to their alkylating properties. The lower molecular weight compounds in this class appear in

general to have greater toxicity. In most cases, the symptoms noted among humans exposed to excessive concentrations of the glycol ethers include headache, drowsiness, lethargy, generalized weakness, irregular and unequal pupils, disorientation, psychopathic behavior, gastrointestinal upset, nocturia, loss of weight, and burning of the eyes (7,8).

Recent results of animal testing (10-13) indicate that exposure to several compounds in the glycol ether family (e.g. 2-methoxyethanol, 2EE, 2-butoxyethanol, and their acetate derivatives) may have the potential to cause reproductive effects in humans. Fetal abnormalities were seen in offspring of exposed female animals (11-13), and testicular atrophy was seen in exposed male animals (10).

The early symptoms of lead intoxication include gastrointestinal disorders, colic, constipation, etc. Other symptoms of lead exposure include fatigue, headache, anemia, peripheral and central nervous system effects, and damage to the kidney (8).

The health effects of chromium depend on the particular oxidation state of the chromium present. In general, the acute and chronic toxicities of chromium compounds in the trivalent state (chromium III) are low compared to chromium compounds in the hexavalent state (chromium VI). Chromium VI compounds are considered to be irritant and corrosive. Also, some of the chromium VI compounds are considered to be carcinogenic. Lead chromate, for example, is a chromium VI compound considered to be a suspect human carcinogen (9,14). Acute exposure to dust or mist of chromium VI compounds may also cause coughing and wheezing, headache, dyspnea, pain on deep inspiration, fever and loss of weight (7,8).

One recommended chromium standard not listed in Table 2 is the American Society for Testing and Materials (ASTM) E 848-82, "Standard Practice for Safety and Health Requirements Relating to Occupational Exposure to Water Insoluble Chromates (19). The ASTM recommends that occupational exposure to hexavalent, water insoluble chromium compounds (listed in Table 1 of the standard), be controlled so that no individual is exposed to concentrations greater than 0.025 mg/m^3 of air (expressed as chromium, equivalent to 0.05 mg/m^3 expressed as CrO_3) as a time weighted average for an eight to ten hour workday. The compounds listed in the standard include most of the commonly used chromate paint pigments, such as lead, zinc, and strontium chromate.

Iron and zinc metal containing dusts are generally considered to be nuisance dusts of relatively low acute or chronic toxicity. Iron oxide dust (as well as the fume, not present during this survey) can also cause a benign, non-fibrotic pneumoconiosis known as siderosis, although roentgenograms may show shadows indistinguishable from fibrotic pneumoconiosis (7). Repeated or prolonged inhalation of manganese primarily affects the central nervous system, causing neuromuscular symptoms such as difficulty in walking or balancing, poor coordination, and shaking or tremor of the hands, arms, and legs. An exposed person may also experience uncontrollable laughter and/or

hallucinations, a condition known as "manganism". Exposure to high concentrations can cause manganese pneumonitis, an influenza-like illness similar to metal fume fever (7).

Irritation, contact dermatitis and sensitization of surface tissues are general characteristics of systemic epoxide toxicity. Reports of irritation resulting from occupational exposure to resins are often confounded by exposure to curing agents mixed with the epoxides. These curing agents, typically polyamines or polyamides, may be irritants themselves, making attribution of the observed effect uncertain.

Epoxy compounds have induced sensitization in human and animal studies. Sensitization of the skin has been reported as a result of occupational exposure to epoxy resins and the epoxide-containing glycidyl ethers which are used as reactive diluents in some epoxy resin systems (20). As is observed with primary irritation, many case reports of sensitization among epoxy workers describe mixed exposure to epoxy compounds and curing agents (such as amines). Experimental animal and human studies have reported skin sensitization when epoxy resins, glycidyl ethers, and amine curing agents were evaluated separately by patch testing (21,22,23). Pulmonary sensitization, manifested by asthma-like reaction has been reported as the result of human exposure to epoxy compounds (24).

Epoxy resins have been found to be mutagenic in bacterial assays. Carcinogenicity of epoxy resins has been widely studied, primarily by animal skin painting. Test results from a number of sources summarized by Hine (24) showed skin carcinogenesis in two strains of mice following dermal exposure to epoxy resins. Apparent synergism between epoxy resins and glycidyl ethers in the induction of skin cancers in animals has been reported.

Table 2
Coating Components and Associated Exposure Limits

Compound	ACGIH TLV* (mg/m^3)	OSHA PEL+ (mg/m^3)	NIOSH Recommended** Standard (mg/m^3)
n-butyl acetate	710	710	—
2-ethoxyethanol	185 (skin)	740	#
2-ethoxyethyl acetate	270 (skin)	540	—
Mineral Spirits	—	—	350
Toluene	375 (skin)	750	375
Xylene	435	435	435
Chromium (Metal & Insoluble salts)	0.5	1	—
Chromium VI (carcinogenic)	—	—	0.001##
Chromium VI (water insoluble)	—	0.05***	—
Iron Dust	@	@	—
Lead Dust	0.15	0.05	0.10++
Manganese Dust	C5	C5	—
Zinc Dust	@	@	—
Nuisance (total) dust	10	15	—

* Threshold Limlit Values for Chemical Substances and Physical Agents in the Work Environment with Intended Changes for 1983-1984. ACGIH. 1983.

\+ Occupational Safety and Health Standards. Subpart Z- Toxic and Hazardous Substances. 40 FR 23072, Section 1910.1000, May 28, 1975.

** NIOSH/OSHA Pocket Guide to Chemical Hazards. National Institute for Occupational Safety and Health; Occupational Safety and Health Administration. 1978

\# NIOSH recommends that exposure be reduced to the lowest extent possible.

— No limit reported.

C Denotes ceiling concentration.

@ See respective (OSHA/ACGIH) nuisance dust standard/recommendation.

++ The NIOSH recommended standard of 0.10 mg/m^3 was considered by OSHA during formal rulemaking. OSHA subsequently promulgated a standard of 0.05 mg/m^3.

NIOSH also recommends that the permissible exposure limit for <u>non-carcinogenic</u> Chromium VI be reduced to 0.025 mg CR(VI)/m^3 averaged over a workshift of up to 10 hours per day, 40 hours per week, with a ceiling of 0.05 mg CR(VI)/m^3 averaged over a 15 minute sample period.

*** ACGIH has listed this standard in Appendix Ala, "Human Carcinogens with an assigned TLV, of its "Threshold Limit Values" booklet (see footnote above).

METHODS

Sampling Strategy

Air sampling for total dust, organic vapors, and specific metals (as listed in Table 2), was conducted over three day shifts during the period March 3-5, 1981. Personal and area samples were collected during representative spray, brush, and roller painting operations, during paint mixing, and during old paint removal operations, as listed in Table 1. Area monitors were placed at each location sampled to determine the composition of airborne vapors and dusts to which the workers were exposed. Personal samples were obtained over a full shift (or as near to it as possible, typically 6-7 hours) to evaluate painters' exposures to the air contaminants listed in Table 2. When possible, sampling during similar operations was repeated on each of the three days of sampling, although some operations were conducted only once or twice during the survey.

Personal sampling was conducted by attaching up to three separate sampling devices to each worker sampled. These included one or two MDA Accuhaler ™ Model 808 low volume pumps, each attached to its own sampling head, and during spray operations, one MSA Model G™ pump.

The MDA pumps were attached to a dual-tube holder designed to sample simultaneously through two organic vapor tubes in parallel. The dual-tube holders were loaded at the beginning of the shift with two SKC™ 150 mg. standard charcoal tubes. The sampling flow rate through each of the tubes was controlled by an individual 50 cc/min. limiting orifice. In non-spray operations, a full-shift sampling methodology was used because of the expected low concentrations of air contaminants. During spray painting, the charcoal tubes were typically changed once during the shift (depending on the length of painting activity during the shift), since spray painting typically generates much higher concentrations of both solvent vapors and spray mist.

During spray painting operations and power-brush removal of paint, the operator was also fitted with one MSA Company Model G™ air sampling pump. The pumps were attached to 3-piece 37mm polystyrene cassettes loaded with preweighed 37mm Millipore™ M-5 polyvinyl chloride membrane (PVC) filters. These were subsequently reweighed in the laboratory and the net weight of total airborne particulate determined. These samples were obtained to determine spray operators' exposures to the total dry weight of spray mist (total spray mist), or total dust in the case of power brushing, and were intended to provide an indication of relative control effectiveness between similar operations. These samples, and those obtained during power-brushing operations, were also analyzed for the metals listed in Table 2. These samples were obtained at a flow rate of 2 lpm. Since heavy filter loading was expected during power brushing operations, the filters were changed at least once, and frequently twice, during each shift.

Bulk samples of the paints and thinners used during the survey were also obtained for later qualitative analysis of the liquid portion. Area samples (i.e. bulk air samples) were also obtained at many of the painting and power brushing operations to aid in identification of air contaminants to which the painters were exposed. These were operated for several hours, at each operation sampled, on one shift only.

The area monitors consisted of MSA Model G pumps, connected to a 37mm cassette containing a 37mm PVC filter (operated at 2 lpm), or a single SKC 150 mg. charcoal tube (operated at 1 lpm). The charcoal tubes and filters were later analyzed qualitatively to determine the composition of airborne contaminants at the location sampled, and to aid in decisions regarding analysis of personal samples. Exposures were not quantitated from these samples.

Sample Analysis

Bulk air charcoal tubes were initially screened by Gas Chromatography (CS2 desorption, flame ionization detection), to determine areas where significant exposure to organic vapors existed. Selected bulk air charcoal tube samples, as well as bulk paint samples, were then analyzed qualitatively by Gas Chromatography-Mass Spectrometry (GC-MS), using a 25 meter methyl silicone fused silica capillary column, to identify all organic vapors present. No benzene was detected in any of these samples, although benzene is frequently found as a low-level contaminant in toluene-xylene solvent mixtures.

Bulk air PVC filters were analyzed qualitatively for metals by Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES). The filters were ashed in a mixture of nitric and perchloric acids. The residues were then dissolved in dilute acid and the resulting solutions were analyzed for trace metal content. The lower limit of quantitation for this sample set was 1.2 ug/filter.

Personal charcoal tubes were subsequently analyzed by gas chromatography via modifications to NIOSH method no. P&CAM 127 (15). Ethoxyethanol (2-EE) and 2EE Acetate (2-EEA) were desorbed with 1 ml of carbon disulfide, and injected into a gas chromatograph equipped with a flame ionization detector (FID), and a 20' stainless steel column packed with 10% SP-1000 on 80/100 Supelcoport. The limit of detection was 0.01/mg/sample. The same basic method was used to quantitate other hydrocarbons, except that a 50 meter fused silica WCOT capillary column coated with 0.25 um SE-30 was used.

Personal PVC filter samples were analyzed for total chromium, iron, manganese, lead, and zinc using a slight modification of NIOSH method P&CAM 173 (Atomic Absorption Spectrophotometry). The filters were wet-ashed in perchloric acid (rather than nitric) at a low temperature to prevent volatilization of chromyl chloride. The samples and standards were then aspirated into the appropriate Atomic Absorption flame (16).

All sample results, for organic vapors, metals, and total dust were calculated in terms of milligrams of analyte per cubic meter of air (mg/m^3). This was done for consistency, and because the molecular weights of several of the complex hydrocarbons (e.g. Solvesso 100™) were not precisely known.

Statistical Analysis and Data Reporting

All sample results were grouped by location (paint shop, turbine, auxilliary, ESF, etc.), which corresponded generally with type of activity. For each of these categories, and for each compound to which exposure occurred, descriptive statistics, including range, arithmetic and geometric mean, arithmetic and geometric standard deviations, and 95% confidence intervals, were determined.

For calculation of statistical parameters such as means, if individual eight hour, time weighted, average concentrations were reported as less than a given value (i.e. the sample analytical weight was less than the limit of detection, or LOD), then a value equal to 50% of the reported "less than" value was assigned . The assumption was made that analytical weight values below the LOD are normally distributed (17).

When two or more hazardous substances, which affect the same organ system, are present, their combined effect should be considered. In the absence of information to the contrary, the effects of the different hazardous compounds should be considered additive. In order to determine workers' equivalent exposures, the following formula has been used (9):

$$TLV = C1/T/+C2/T2+ \ . \ . \ .Cn/Tn$$

Where: Ci = observed atmospheric concentration
Ti = corresponding Threshold Limit Value

If the sum of the fraction exceeds unity, then the Threshold Limit Value is exceeded. For the purposes of this survey, the effect of all the organic vapors to which the painters were exposed was assumed to be additive, since all have greater or lesser effects on the central nervous system.

RESULTS AND DISCUSSION

Appendix B (Tables B-1 to B-12), contains the individual raw sample results for all compounds and jobs sampled. Tables B-1 to B-6 include the data for the organic compounds evaluated, and Tables B-7 to B-12 the data for inorganic compounds and total particulate weights. Descriptive statistics for all substances and jobs are presented in Appendix C, Tables C-1 to C-12. Table 3, in the text following, contains the calculated geometric mean exposures, and ranges (over all jobs), to all contaminants measured. Appendix D contains the results of real-time measurements of total hydrocarbons in air with an HNU™ Company Photo Ionization Detector (scale range 0-200 ppm).

Table 3

Exposures of Painters and Allied Workers
To Airborne Contaminants (All Areas)
Millstone Plant #3, Waterford, Conn.; March, 1981

Compound	Geometric Mean (Min., Max.); mg/m^3				
	Paint Shop	Turbine Bldg.	Auxilliary Bldg.	Containment Bldg.	ESF* Bldg.
Toluene	* (1.3, 2)	* (<0.4, <0.6)	* (<0.5, <0.6)	* (<0.4, 2)	* (.4, 2)
Xylene	* (1, 6)	1 (1, 1)	22.5 (4.7, 108)	3.8 (1, 12)	33 (16, 52)
2-EE	2 (2, 2)	* (<0.5, <0.7)	13 (7.9, 20)	1.2 (0.2, 11)	33 (14, 72)
2-EEA	* (0.6, 11)	* (<0.5, <0.7)	* (<0.6, 1)	* (<0.4, 2)	5.2 (3, 10)
Butyl acetate	2 (0.9, 3)	* (<0.4, <0.6)	23 (16, 33)	1.8 (0.2, 18)	47 (25, 73)
Mineral Spirits	* (3, 5)	* (<2, 2)	4.8 (4.7, 5)	2.3 (<0.2, 6.3)	29 (17-47)
Iron Dust	19 (+)	97 (39, 209)	1.8 (1.2, 9.7)	8.3 (1.8, 190)	0.25 (0.23, 0.26)
Manganese	0.14 (+)	0.72 (0.24, 1.9)	0.02 (0.01, 0.07)	0.1 (0.03, 2.1)	* (0.002, 0.005)
Zinc	0.06 (+)	0.33 (0.14, 0.54)	0.01 (0.003, 0.03)	2.9 (0.67, 5.4)	0.01 (0.007, 0.02)
Nuisance - (total) dust	30 (+)	203 (84, 430)	25 (12, 43)	70 (17, 1000)	27 (17, 41)
Lead dust	0.35 (+)	4.2 (1.5, 7.8)	0.46 (0.19, 1.4)	0.2 (0.03, 20.6)	0.01 (0.004, 0.02)
Chromium Dust (as Cr)	0.07 (+)	0.2 (0.06, 0.4)	0.04 (0.03, 0.05)	0.12 (0.03, 2.4)	0.03 (.026, 0.35)

* No statistical analysis performed since greater than 50% of concentrations were less than the limit of detection.
+ One sample only.

Organic Compounds

In general, exposures to organic compounds were quite low relative to current exposure standards and recommendations (Table 2). There were no exposures to individual organic vapors in excess of the current OSHA PEL, or NIOSH or ACGIH recommendations. However, in the cases of 2-EE and 2-EEA (also known as ethylene glycol monoethyl ether and ethylene glycol monoethyl ether acetate, respectively), it is not known whether the current TLV constitutes adequate protection against potential reproductive health effects seen recently in animals (1-5). Over all areas, geometric mean 2-EE exposures (exclusive of respiratory protection worn) ranged up to 33 mg/m^3 (Table 3). Individual 2-EE exposures in these areas ranged from non-detectable (<0.4 mg/m^3) to 72 mg/m^3 (Table B-5). Similarly, geometric mean exposures to 2-EEA ranged up to 5.2 mg/m^3, and individual 2-EEA exposures from non-detectable (<0.6 mg/m^3) to 11 mg/m^3.

Not surprisingly, the highest apparent exposures to 2-EE, as well as other volatile solvents, were in the ESF building during compressed air spray painting of the walls of an interior room with epoxy primer (Table 3). Personal exposures to 2-EE ranged from 14 to 72 mg/m^3 (geometric mean of 33 mg/m^3). This compares with the current ACGIH TLV of 185 mg/m^3 (with a "skin" notation), and the OSHA PEL of 740 mg/m^3. NIOSH does not currently recommend a specific standard for concentrations of either 2-EE or 2-EEA in air, but does recommend that exposures be reduced to the greatest extent possible.

The single highest personal exposure to 2-EEA (11 mg/m^3) was during paint mixing in the Paint Shop. The glycol ethers (as well as other solvents) were present in the two part epoxy paints being mixed. Exposures of the spray painters in the ESF building ranged from 3 to 10 mg/m^3. By comparison, the current ACGIH TLV is 270 mg/m^3 ("skin" notation), and the OSHA PEL is 540 mg/m^3.

Exposures to toluene, xylenes, n-butyl acetate, and Solvesso 100™ (similar to mineral spirits) are summarized in Table 3. All exposures to the individual compounds were a very small fraction of the standards or recommendations for these compounds (Table 2). The most notable personal exposure(s) were to xylene (range: 4.7-108 mg/m^3, geometric mean: 22.5 mg/m^3) during brush painting in the Auxilliary Building. In this case, the highest exposure (108 mg/m^3) was approximately one-fourth of the NIOSH recommended standard of 435 mg/m^3 (which is also the OSHA PEL and the ACGIH TLV).

Since the spray painters working in the ESF building were consistently exposed to the highest concentrations of all solvents measured, the most highly exposed painter's (person code 002, on 3/4/81) Threshold Limit Value for solvent mixtures was calculated. In the case of Solvesso 100™, a petroleum hydrocarbon similar to mineral spirits, the NIOSH recommended standard for mineral spirits (350 mg/m^3) was substituted into the calculation in the absence of a specific TLV for mineral spirits. The

calculated, additive TLV in this case was 0.78 (i.e. 78% of the Threshold Limit Value for the mixture). Since all other exposures to organic vapors were considerably lower (Tables B-1 to B-6), it is clear that no measured exposures to mixtures of solvents exceeded the TLV during the survey.

Table D-1 (Appendix D) indicates the results of measurements of instantaneous total hydrocarbon concentrations with an HNU Company Photo Ionization detector during various specific activities in the ESF building and the Paint Shop. The highest concentrations were recorded during the cleaning of paint lines, paint pot, and other equipment with solvent during spray painting activities in the ESF building. Concentrations during spray painting (Table D-1) ranged from 40 to 150 ppm.

Total Dust (Spray Mist) and Metals

The results of samples obtained to evaluate spray painters' exposures to metals and total spray mist (in spray operations), and other painters' exposures to metals and total nuisance dust during power-brush removal of old paint, are summarized in Table 3.

In general, exposures to total dust were quite high during paint removal operations. In the Turbine building, the geometric mean exposure to total dust was 203 mg/m^3, with individual eight hour, time weighted, average exposures ranging from 84 to 430 mg/m^3. Exposures to total spray mist during compressed air spray painting in the ESF building ranged from 17 to 41 mg/m^3, with a geometric mean of 27 mg/m^3. These exposures compare with the accepted ACGIH TLV for exposure to nuisance dust of 10 mg/m^3, and the corresponding OSHA PEL of 15 mg/m^3. In general, these dust levels reflect the relatively uncontrolled environmental conditions under which the power brushing was done. No local exhaust systems (portable or otherwise) were used, nor were other techniques employed (such as wet grinding) to control generation of dust.

Analysis of the same filters for five metals indicated that personal, eight hour, time weighted average exposures to iron, manganese, and zinc (Table 3) were generally well within their corresponding standards or recommendations (Table 2). Exposures to iron dust during paint removal in the Containment building (1.8-190 mg/m^3) and in the Turbine building (39-209 mg/m^3), frequently exceeded the standards and recommendations for nuisance dust.

Exposures to inorganic lead in dust generated by removal of paint in the Turbine, Auxilliary, and Containment buildings were frequently and greatly in excess of the OSHA PEL (0.05 mg/m^3), as well as the NIOSH (0.1 mg/m^3) and ACGIH (0.15 mg/m^3) recommended levels for eight to ten hour (full-shift) exposures. The highest, single exposure (20.6 mg/m^3) resulted from paint removal operations in the Containment building. The highest geometric mean exposure (4.2 mg/m^3), however, was during similar operations in the Auxilliary building. Individual personal exposures to lead in dust in the Auxilliary building ranged from 1.5 to 7.8 mg/m^3. During spray painting in the ESF building, exposures ranged from 0.004 to

0.02 mg/m^3, with a geometric mean of 0.01 mg/m^3, detectable but within current standards. Overall, 9 of 15 (60%) of the time weighted, average exposure measurements (Table B-10) were in excess of the OSHA PEL.

Table 3 also summarizes the results of analyses of the filter samples for total chromium. The results are all expressed as milligrams of total chromium metal (as Cr) per cubic meter of air (mg/m^3).

During spray painting in the ESF building, personal eight hour, time weighted, average exposures of painters to total chromium (as Cr), ranged from 0.026 to 0.04 mg/m^3, with a geometric mean of 0.03 mg/m^3. However, exposures during paint removal with power brushes were considerably higher. Personnel exposures to total Cr during paint removal in the Containment building ranged from 0.03 to 2.4 mg/m^3 (geometric mean: 0.12 mg/m^3). Similarly, goemetric mean exposures in the Auxilliary and Turbine buildings during paint removal were 0.04 and 0.2 mg/m^3, respectively. The Paint Mixer's exposure during the one shift sampled was 0.1 mg/m^3. The latter exposure was undoubtedly due to the normal movement of the Paint Mixer throughout the plant during the shift, and to consequent exposure to dusts generated in the areas visited.

Without knowing the exact form of chromium to which the various workers were exposed, it is difficult to interpret these exposures. The standards and recommendations for chromium (Table 2) depend not only on the valence state of the metal, but also the specific compound to which workers are exposed.

In general, however, if the form of chromium to which the painters were exposed was one of the insoluble hexavalent chromium compounds (e.g. lead, zinc, or strontium chromate), then most of these exposures were in excess of the applicable standards or recommendations. The NIOSH recommended permissible exposure limit for carcinogenic Cr(VI), for example, is 0.001 mg/m^3 for up to an eight hour workshift or 40 hour week. The corresponding applicable ACGIH TLV for "certain water insoluble" chromium VI compounds is 0.05 mg/m^3. All measured exposures were in excess of the NIOSH and ASTM (0.025 mg/m^3) recommendations, while 6 of 15 (40%) of the eight hour, time weighted, average exposures were in excess of the TLV.

On the other hand, if the chromium found in the samples was not hexavalent (i.e. Chromium metal, or chromium II or III compounds), then only one measured exposure, that of a painter during paint removal in the Containment Building, was in excess of applicable standards (the ACGIH TLV is 0.5 mg/m^3; the OSHA PEL is 1 mg/m^3). NIOSH has no specific recommendation for chromium metal).

Under the circumstances, where the type of paint pigment used in the old paint was not known, it would be most prudent to assume that the workers were exposed to the insoluble hexavalent Cr(VI) compounds which are suspected of being carcinogenic to humans, and thus apply the most stringent standard. This conclusion seems likely to be correct, since the application in question, (corrosion protection of steel surfaces) suggests the use of

zinc or lead chromate, which are frequently used as pigments in primers designed for protection against corrosion. At least one of the inorganic zinc primers occasionally used at the plant, Ameron Dimetcote No. 6, contains approximately 3% lead chromate pigment, according to the Company supplied material safety data sheet.

CONCLUSIONS AND RECOMMENDATIONS

Based on the sampling data presented in this report, and subjective observations of painting operations in progress during the survey, exposures to organic solvents were well within current standards and recommendations (Table 2). No exposures to individual organic vapors were in excess of the current OSHA PEL, or NIOSH or ACGIH recommendations. Additive exposures to mixtures of solvents also were not excessive with respect to current TLVs.

However, exposures to 2-ethoxyethanol ranged from non-detectable ($<0.04 mg/m^3$) to 72 mg/m^3, and geometric means ranged up to 33 mg/m^3. The highest single concentration of 72 mg/m^3 was approximately one-half of the current ACGIH TLV (185 mg/m^3). NIOSH does not currently recommend a specific permissible exposure concentration, but recommends that exposures be reduced as much as possible (18). Given the NIOSH recommendation, and current knowledge regarding the potential reproductive health effects in humans based on studies in animals, the company should consider the institution of additional control measures to lower exposures to glycol ethers, or the substitution of products which do not contain these compounds.

Exposures of painters to lead (and possibly chromium) during power brush removal of old paint in various areas were frequently in excess of applicable standards and recommendations (Table 2) in the Auxilliary, Turbine, and Containment Buildings (Table 3). Total dust levels were also grossly in excess of applicable nuisance dust standards and recommendations during paint removal operations in these areas (Table 3).

Engineering control of dust, and respiratory protection used during these operations (usually 3M Company No. 8710 single use respirators), given the measured exposures to lead, chromium, and total dust, were totally inadequate. Additional (possibly portable) local exhaust systems should be considered for use during power brush removal of old paint. Alternatively, wet grinding methods, using water, may be of some benefit. In any event, implementation of additional controls, better respiratory protection, and more care in work practices would be prudent where (generally) the hazards are poorly understood or unknown. Additionally, since the possibility exists of painter exposure to carcinogenic forms of Chromium VI, recommendations specified in the NIOSH Criteria Document pertaining to Chromium VI (14) should be considered.

REFERENCES

1. Selikof, I.J.. Investigation of Health Hazards in the Painting Trades. Contract CDC-99-74-91. Mt. Sinai School of Medicine of the City of New York. 1975.

2. Axelson, O., M. Hane, and C. Hogstedt. A Case Referent Study on Neuro-psychiatric Disorders Among Workers Exposed to Solvents. Scandinavian Journal of Work, Environment, and Health, 2:14-20. 1976.

3. Sundell, L., O. Axelson, J. Blume, M. Hane, C. Hogstdet, and B. Ydreborg. Investigations of Housepainters Exposed to Different Paints and Solvents. Bull. Inst. Marit. Trop. Med. Gdynia, 28:1-2. 1976.

4. Hanninen, H., L. Eskilinen, K. Husman, and M. Nurminen. Behavioral Effects of Long-Term Exposure to a Mixture of Organic Solvents. Scandinavian Journal of Work, Environment, and Health, 4:240-255. 1976.

5. Malov, J.S. MBK Nueropathy Among Spray Painters. Journal of the American Medical Assoc., 235(14):1455-1457. 1976.

6. National Institute for Occupational Safety and Health. Walk-Through Survey Report, Millstone Plant #3, Waterford, Connecticut. (IWSB 74.69). 1980.

7. U.S. Dept. of Health and Human Services, Cincinnati, Ohio, and the U.S. Dept. of Labor, OSHA, Washington, D.C. NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards. Publication No. 81-123. 1981.

8. Clayton, D., and F.E. Clayton. (Editors). Patty's Industrial Hygiene and Toxicology, Vol. 2A, 2B, and 2C. Interscience Publishers, Inc. NY, NY. 1981.

9. American Conference of Governmental Industrial Hygienists. Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment with Intended Changes for 1983-1984. 1983.

10. Nagano, K., E. Nakayama, M. Koyano, H. Dobayaski, H. Adachi, and T. Yamada. Testicular Atrophy of Mice Induced by Ethylene Glycol Monoalkyl Ether. Jap. J. Ind. Health, 21:29-35. 1979.

11. Nelson, B.K., W.S. Brightwell, J.V. Setzer, B.J. Taylor, and R.W. Horning. Ethoxyethanol Behavioral Teratology in Rats. Teratology, 21:58A. 1980.

12. Stenger, E.G., L. Aeppli, D. Mueller, E. Peheim, and P. Thomann. Toxicology of Ethylene Glycol Mono-ethyl ether. Arzincim. -Frosch, 21(6):880-885. 1971.

13. Wiley, F.H., W.C. Hueper, D.S. Bergen, and F.R. Blood. The Formation of Oxalic Acid From Ethylene Glycol and Related Solvents.

14. National Institute for Occupational Safety and Health. Criteria for a Recommended Standard...Occupational Exposure to Chromium (VI). NIOSH Publication No. 76-129. 1975.

15. National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Methods, Organic Solvents in Air, P&CAM 127, Vol. 1, U.S. Dept. of Health and Human Services, Cincinnati, Ohio. NIOSH Publication No. 77-157-A. 1978.

16. National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Methods, General Procedures for Metals, P&CAM 173, Vol. 1, U.S. Dept. of Health and Human Services, Cincinnati, Ohio. NIOSH Publication No. 77-157-A. 1978.

17. Leidel, N., K.A. Busch, and J.R. Lynch. Occupational Exposure Sampling Strategy Manual. U.S. DHEW, Cincinnati, Ohio. NIOSH Publication No. 77-173. 1977.

18. National Institute for Occupational Safety and Health. Current Intelligence Bulletin No. 29...Glycol Ethers. NIOSH Publication No. 83-112. 1983.

19. American Society for Testing and Materials. E 848-82; Safety and Health Requirements Relating to Occupational Exposure to Water-Insoluble Chromates. 1982.

20. National Institute for Occupational Safety and Health. Occupational Exposure to Glycidyl Ethers. Criteria for a Recommended Standard, DHEW (NIOSH) Publication No. 78-166. 1978.

21. Lea, W.A. et al. The Irritating and Sensitizing Capacity of Epoxy Resins. AMA Archives of Dermatology 78:304-308. 1950.

22. Fregert, S. and H. Porsman. Allergens in Epoxy Resins. Acta Allergologica XIX:296-299. 1964.

23. Cornish, H.H. and W.D. Block. The Toxicology of Uncured Epoxy Resins and Amine Curing Agents. AMA Archives of Industrial Health. 20:390-398. 1959.

24. Hine, C.H. et al. Epoxy Compounds, Chapter 32, Patty's Industrial Hygiene and Toxicology, Vol. IIa, 3rd ed., Clayton, G.D. and Clayton, F.E., editors, Wiley-Interscience, New York. 1981.

APPENDIX A

Figure 1: Simplified Plot Diagram Millstone Nuclear Power Station #3

Figure 2: Cutaway Drawing, Spray Painting, ESF Building

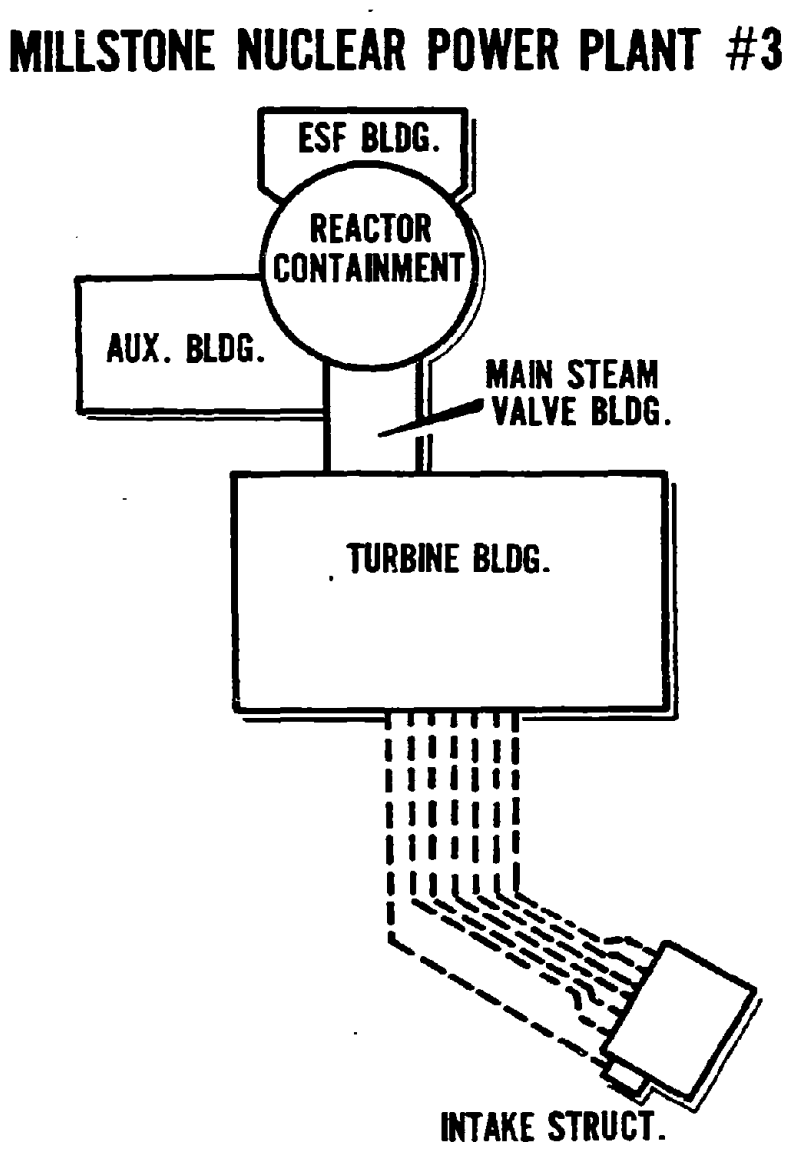
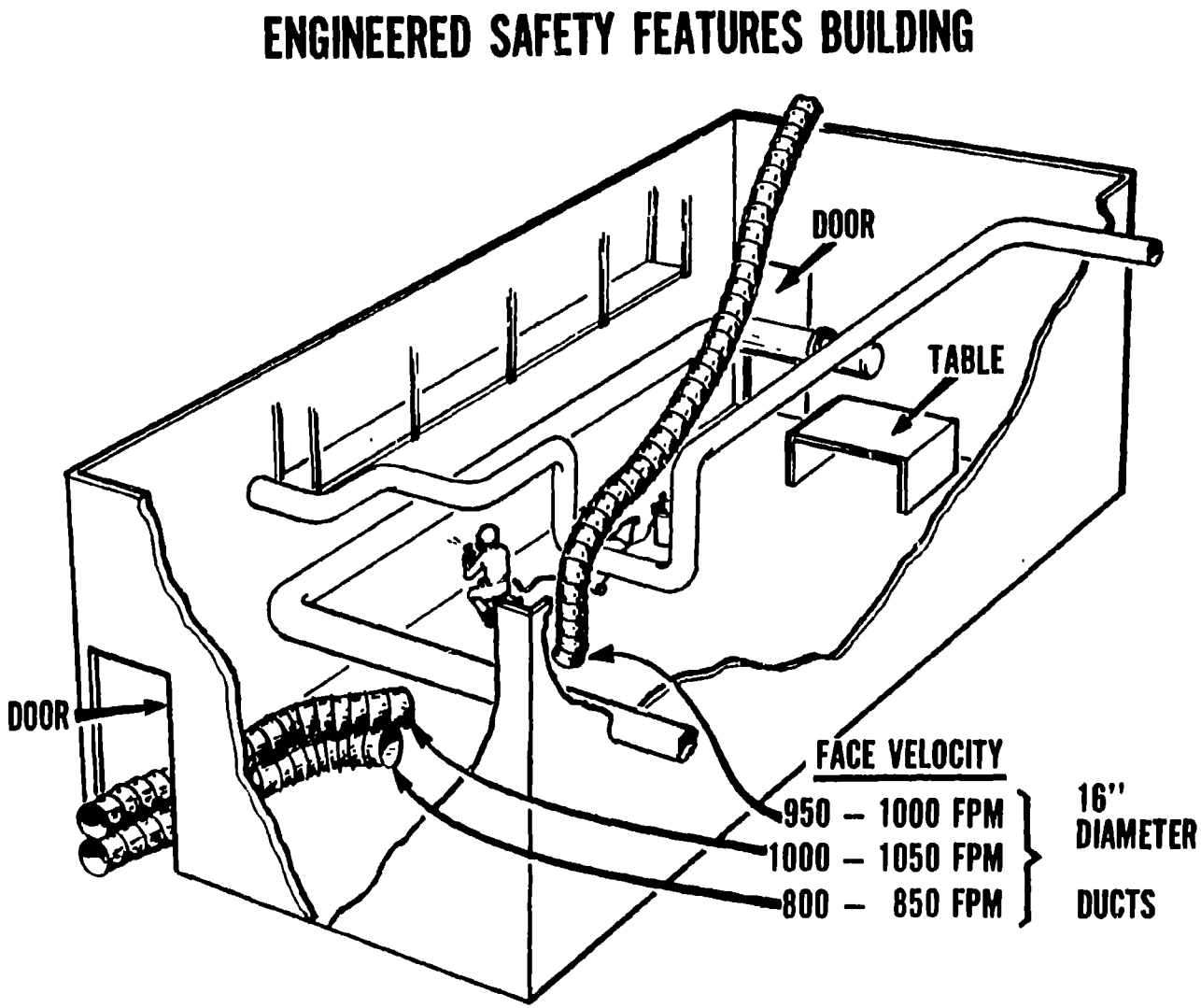


Figure A1. Simplified Plot Diagram, Millstone Nuclear Power Station #3

Figure A2. Cutaway Drawing, Spray Painting



APPENDIX B

Sampling Results
Tables B-1 - B-12

TABLE B-1 SAMPLING RESULTS: TOLUENE
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3,4]
A10	001	3/4/81	Mixer/Paint Shop	--	51	0.001	<0.01	<10	--
A45	001	3/4/81	Mixer/Paint Shop	--	372	0.011	<0.01	<2	1.3
A27	001	3/5/81	Mixer/Paint Shop	--	72	0.003	<0.01	<3	--
A77	001	3/5/81	Mixer/Paint Shop	--	371	0.009	0.02	2	2
A02	006	3/4/81	Painter/Turbine	2,3	369	0.016	<0.01	<0.6	<0.5
A40	007	3/4/81	Painter/Turbine	2	375	0.018	<0.01	<0.5	<0.4
A22	N.R.*	3/4/81	Painter/Turbine	N.R.*	350	0.012	<0.01	<0.9	<0.6
A47	008	3/3/81	Painter/Auxiliary	2	126	0.005	<0.01	<2	***
A15	008	3/4/81	Painter/Auxiliary	2	405	0.018	<0.01	<0.6	<0.5
A76	008	3/5/81	Painter/Auxiliary	2	424	0.015	<0.01	<0.7	<0.6
A08	007	3/3/81	Painter/Containment	2	319	0.014	<0.01	<0.7	<0.5
A13	010	3/3/81	Painter/Containment	2	306	0.016	<0.01	<0.6	<0.4
A12	009	3/4/81	Painter/Containment	1,2	342	0.017	<0.01	<0.6	<0.4
A50	004	3/4/81	Painter/Containment	2	318	0.014	0.04	3	2
A05	005	3/4/81	Painter/Containment	2	344	0.016	<0.01	<0.7	<0.5
A14	N.R.*	3/5/81	Painter/Containment	N.R.*	122	0.005	<0.01	<2	***
A75	N.R.*	3/5/81	Painter/Containment	N.R.*	417	0.020	<0.01	<0.5	<0.5
A59	002	3/4/81	Painter/ESF**	1	405	0.015	0.04	3	2
A42	002	3/5/81	Painter/ESF**	1	230	0.009	<0.01	<1	--
A06	002	3/5/81	Painter/ESF**	1	156	0.006	<0.01	<2	0.5
A16	003	3/4/81	Painter/ESF**	1	185	0.010	0.02	2	--
A39	003	3/4/81	Painter/ESF**	1	151	0.006	0.02	2	1
A30	003	3/5/81	Painter/ESF**	1	218	0.007	<0.01	<1	--
A26	003	3/5/81	Painter/ESF**	1	152	0.007	<0.01	<1	0.4

* Not Recorded
** Engineered Safety Features Building
*** No 8-TWA determined due to insufficient sample period.
1 Activity: 1-Compressed Air Spray Painting; 2) Brush Painting; 3) Roller Painting; 4) Power Brush
2 Non-detectable values were reported as less than (<) the detection limit of the analytical instrument. The limit of detection for Toluene was 0.01 milligrams (mg) per sample.
3 Exposure during the 8-hour time period not sampled was assumed to be zero.
4 In cases where 1) determination of the 8-TWA involves consideration of more than one sample obtained during the 8-hour time period, and where 2) one or more of the sample concentrations was reported as less than the detection limit, a value of 50% of the "less than" sample concentration was used in the determination. The 8-TWA thus determined is a finite value.

TABLE B-2 SAMPLING RESULTS: XYLENE
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3,4]
A10	001	3/4/81	Mixer/Paint Shop	--	51	0.001	<0.01	<10	--
A45	001	3/4/81	Mixer/Paint Shop	--	372	0.011	<0.01	<0.9	1
A27	001	3/5/81	Mixer/Paint Shop	--	72	0.003	<0.01	<3	--
A77	001	3/5/81	Mixer/Paint Shop	--	371	0.010	0.08	8	6
A02	006	3/4/81	Painter/Turbine	2,3	369	0.015	0.02	1	1
A40	007	3/4/81	Painter/Turbine	2	375	0.018	0.02	1	1
A22	N.R.*	3/4/81	Painter/Turbine	N.R.*	350	0.011	0.02	2	1
A47	008	3/3/81	Painter/Auxiliary	2	126	0.005	0.04	8	***
A15	008	3/4/81	Painter/Auxiliary	2	405	0.018	0.10	5.6	4.7
A76	008	3/5/81	Painter/Auxiliary	2	424	0.015	1.84	123	108
A08	007	3/3/81	Painter/Containment	2	319	0.014	0.03	2	1
A13	010	3/3/81	Painter/Containment	2	306	0.016	0.30	19	12
A12	009	3/4/81	Painter/Containment	1,2	342	0.017	0.06	4	3
A50	004	3/4/81	Painter/Containment	2	318	0.014	0.09	6	4
A05	005	3/4/81	Painter/Containment	2	344	0.016	0.10	6.2	4.5
A14	N.R.*	3/5/81	Painter/Containment	N.R.*	122	0.005	0.07	14	***
A75	N.R.*	3/5/81	Painter/Containment	N.R.*	417	0.020	0.10	5	4.3
A59	002	3/4/81	Painter/ESF**	1	405	0.015	0.92	61	52
A42	002	3/5/81	Painter/ESF**	1	230	0.009	0.55	61	--
A06	002	3/5/81	Painter/ESF**	1	156	0.006	0.20	33	40
A16	003	3/4/81	Painter/ESF**	1	185	0.010	0.26	26	--
A39	003	3/4/81	Painter/ESF**	1	151	0.006	0.53	88	37
A30	003	3/5/81	Painter/ESF**	1	218	0.007	0.19	27	--
A26	003	3/5/81	Painter/ESF**	1	152	0.007	0.09	13	16

* Not Recorded
** Engineered Safety Features Building
*** No 8-TWA determined due to insufficient sample period.
1 Activity: 1-Compressed Air Spray Painting; 2) Brush Painting; 3) Roller Painting; 4) Power Brush
2 Non-detectable values were reported as less than (<) the detection limit. The limit of detection for Xylene was 0.01 milligrams (mg) per sample.
3 Exposure during the 8-hour time period not sampled was assumed to be zero.
4 In cases where 1) determination of the 8-TWA involves consideration of more than one sample obtained during the 8-hour time period, and where 2) one or more of the sample concentration was reported as less than the detection limit, a value of 50% of the "less than" sample concentration was used in the determination. The 8-TWA thus determined is a finite value.

TABLE B-3 SAMPLING RESULTS: BUTYL ACETATE
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3,4]
A10	001	3/4/81	Mixer/Paint Shop	--	51	0.001	<0.01	<10	--
A45	001	3/4/81	Mixer/Paint Shop	--	372	0.011	<0.01	< 0.9	0.9
A27	001	3/5/81	Mixer/Paint Shop	--	72	0.003	0.02	7	--
A77	001	3/5/81	Mixer/Paint Shop	--	371	0.010	0.03	3	3
A02	006	3/4/81	Painter/Turbine	2,3	369	0.016	<0.01	<0.6	<0.5
A40	007	3/4/81	Painter/Turbine	2	375	0.018	<0.01	<0.6	<0.4
A22	N.R.*	3/4/81	Painter/Turbine	N.R.*	350	0.012	<0.01	<0.8	<0.6
A47	008	3/3/81	Painter/Auxiliary	2	126	0.005	0.08	16	***
A15	008	3/4/81	Painter/Auxiliary	2	405	0.018	0.35	19	16
A76	008	3/5/81	Painter/Auxiliary	2	424	0.015	0.56	37	33
A08	007	3/3/81	Painter/Containment	2	319	0.014	<0.01	<0.7	<0.5
A13	010	3/3/81	Painter/Containment	2	306	0.016	<0.01	<0.6	<0.4
A12	009	3/4/81	Painter/Containment	1,2	342	0.019	0.42	25	18
A50	004	3/4/81	Painter/Containment	2	318	0.014	0.03	2	1
A05	005	3/4/81	Painter/Containment	2	344	0.016	0.22	16	11
A14	N.R.*	3/5/81	Painter/Containment	N.R.*	122	0.005	0.10	20	***
A75	N.R.*	3/5/81	Painter/Containment	N.R.*	417	0.020	0.09	5	4
A59	002	3/4/81	Painter/ESF**	1	405	0.015	1.3	87	73
A42	002	3/5/81	Painter/ESF**	1	230	0.009	0.47	52	--
A06	002	3/5/81	Painter/ESF**	1	156	0.006	0.29	49	41
A16	003	3/4/81	Painter/ESF**	1	185	0.010	0.57	57.0	--
A39	003	3/4/81	Painter/ESF**	1	151	0.006	0.79	131	63
A30	003	3/5/81	Painter/ESF**	1	218	0.007	0.30	43	--
A26	003	3/5/81	Painter/ESF**	1	152	0.007	0.12	17	25

* Not Recorded
** Engineered Safety Features Building
*** No 8-TWA determined due to insufficient sample period.
1 Activity: 1-Compressed Air Spray Painting; 2) Brush Painting; 3) Roller Painting; 4) Power Brush
2 Non-detectable values were reported as less than (<) the detection limit. The limit of detection for n-Butyl Acetate was 0.01 milligrams (mg) per sample.
3 Exposure during the 8-hour time period not sampled was assumed to be zero.
4 In cases where 1) determination of the 8-TWA involves consideration of more than one sample obtained during the 8-hour time period, and where 2) one or more of the sample concentrations was reported as less than the detection limit, a value of 50% of the "less than" sample concentration was used in the determination. The 8-TWA thus determined is a finite value.

TABLE B-4 SAMPLING RESULTS: SOLVESSO 100[R] (MINERAL SPIRITS)
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3,4]
A10	001	3/4/81	Mixer/Paint Shop	--	51	0.001	<0.05	<50	--
A45	001	3/4/81	Mixer/Paint Shop	--	372	0.011	<0.05	< 5	5
A27	001	3/5/81	Mixer/Paint Shop	--	72	0.003	<0.05	<17	--
A77	001	3/5/81	Mixer/Paint Shop	--	371	0.010	<0.05	< 5	3
A02	006	3/4/81	Painter/Turbine	2,3	369	0.016	<0.05	< 3	<2
A40	007	3/4/81	Painter/Turbine	2	375	0.018	0.05	3	2
A22	N.R.*	3/4/81	Painter/Turbine	N.R.*	350	0.012	<0.05	< 4	<3
A47	008	3/3/81	Painter/Auxiliary	2	126	0.005	<0.05	<10.0	***
A15	008	3/4/81	Painter/Auxiliary	2	405	0.018	0.10	5.6	4.7
A76	008	3/5/81	Painter/Auxiliary	2	424	0.015	0.08	5	5
A08	007	3/3/81	Painter/Containment	2	319	0.014	0.05	4	2
A13	010	3/3/81	Painter/Containment	2	306	0.016	<0.05	< 3	<2
A12	009	3/4/81	Painter/Containment	1,2	342	0.017	0.15	8.8	6.3
A50	004	3/4/81	Painter/Containment	2	318	0.014	0.08	6	4
A05	005	3/4/81	Painter/Containment	2	344	0.016	0.06	4	3
A14	N.R.*	3/5/81	Painter/Containment	N.R.*	122	0.005	<0.05	<10	***
A75	N.R.*	3/5/81	Painter/Containment	N.R.*	417	0.020	<0.05	< 3	<2
A59	002	3/4/81	Painter/ESF**	1	405	0.015	0.83	55	47
A42	002	3/5/81	Painter/ESF**	1	230	0.009	0.34	38	--
A06	002	3/5/81	Painter/ESF**	1	156	0.006	0.08	13	22
A16	003	3/4/81	Painter/ESF**	1	185	0.010	0.39	39	--
A39	003	3/4/81	Painter/ESF**	1	151	0.006	0.52	86	42
A30	003	3/5/81	Painter/ESF**	1	218	0.007	0.25	36	--
A26	003	3/5/81	Painter/ESF**	1	152	0.007	<0.05	< 7	17

* Not Recorded
** Engineered Safety Features Building
*** No 8-TWA determined due to insufficient sample period.
1 Activity: 1-Compressed Air Spray Painting; 2) Brush Painting; 3) Roller Painting; 4) Power Brush
2 Non-detectable values were reported as less than (<) the detection limit. The limit of detection for Solvesso 100[R] was 0.05 milligrams (mg) per sample.
3 Exposure during the 8-hour time period not sampled was assumed to be zero.
4 In cases where 1) determination of the 8-TWA involves consideration of more than one sample obtained during the 8-hour time period, and where 2) one or more of the sample concentrations was reported as less than the detection limit, a value of 50% of the "less than" sample concentration was used in the determination. The 8-TWA thus determined is a finite value.

TABLE B-5 SAMPLING RESULTS: ETHYLENE GLYCOL MONOETHYL ETHER (2EE)
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3,4]
B03	001	3/4/81	Mixer/Paint Shop	--	51	0.001	<0.01	<10	--
B46	001	3/4/81	Mixer/Paint Shop	--	372	0.012	0.02	2	2
B28	001	3/5/81	Mixer/Paint Shop	--	72	0.004	<0.01	< 3	--
B78	001	3/5/81	Mixer/Paint Shop	--	371	0.009	0.02	2	2
B32	006	3/4/81	Painter/Turbine	2,3	369	0.017	<0.01	< 0.6	< 0.5
B38	007	3/4/81	Painter/Turbine	2	375	0.016	<0.01	< 0.6	< 0.5
B29	N.R.*	3/4/81	Painter/Turbine	2	350	0.011	<0.01	< 0.9	< 0.7
B57	008	3/3/81	Painter/Auxiliary	2	126	0.005	0.03	6	***
B07	008	3/4/81	Painter/Auxiliary	2	405	0.017	0.16	9.4	7.9
B70	008	3/5/81	Painter/Auxiliary	2	424	0.015	0.34	23	20
B09	007	3/3/81	Painter/Containment	2	319	0.012	<0.01	< 0.8	< 0.6
B17	010	3/3/81	Painter/Containment	2	306	0.016	<0.01	< 0.6	< 0.4
B31	009	3/4/81	Painter/Containment	1,2	342	0.015	0.23	15	11
B35	004	3/4/81	Painter/Containment	2	318	0.014	0.01	0.7	0.5
B11	005	3/4/81	Painter/Containment	2	344	0.014	0.11	7.9	5.6
B18	N.R.*	3/5/81	Painter/Containment	N.R.*	122	0.005	0.06	12	***
B64	N.R.*	3/5/81	Painter/Containment	N.R.*	417	0.018	0.04	2	2
B60	002	3/4/81	Painter/ESF**	1	405	0.014	1.2	86	72
B44	002	3/5/81	Painter/ESF**	1	230	0.010	0.43	43	--
B04	002	3/5/81	Painter/ESF**	1	156	0.006	0.20	33	31
B01	003	3/4/81	Painter/ESF**	1	185	0.010	0.48	48	--
B25	003	3/4/81	Painter/ESF**	1	151	0.004	0.25	63	38
B24	003	3/5/81	Painter/ESF**	1	218	0.007	0.02	3	--
B34	003	3/5/81	Painter/ESF**	1	152	0.007	0.28	40	14

* Not Recorded
** Engineered Safety Features Building
*** No 8-TWA determined due to insufficient sample period.
1 Activity: 1-Compressed Air Spray Painting; 2) Brush Painting; 3) Roller Painting; 4) Power Brush
2 Non-detectable values were reported as less than (<) the detection limit. The limit of detection for 2EE was 0.01 milligrams (mg) per sample.
3 Exposure during the 8-hour time period not sampled was assumed to be zero.
4 In cases where 1) determination of the 8-TWA involves consideration of more than one sample obtained during the 8-hour time period, and where 2) one or more of the sample concentrations was reported as less than the detection limit, a value of 50% of the "less than" sample concentration was used in the determination. The 8-TWA thus determined is a finite value.

TABLE B-6 SAMPLING RESULTS: ETHYLENE GLYCOL MONOETHYL ETHER ACETATE (2EEA)
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3,4]
B03	001	3/4/81	Mixer/Paint Shop	--	51	0.001	<0.01	<10	--
B46	001	3/4/81	Mixer/Paint Shop	--	372	0.012	0.17	14	11
B28	001	3/5/81	Mixer/Paint Shop	--	72	0.004	<0.01	< 3	--
B78	001	3/5/81	Mixer/Paint Shop	--	371	0.009	<0.01	< 1	0.6
B32	006	3/4/81	Painter/Turbine	2,3	369	0.017	<0.01	< 0.6	< 0.5
B38	007	3/4/81	Painter/Turbine	2	375	0.016	<0.01	< 0.6	< 0.5
B29	N.R.*	3/4/81	Painter/Turbine	2	350	0.011	<0.01	< 0.9	< 0.7
B57	008	3/3/81	Painter/Auxiliary	2	126	0.005	<0.01	< 2	***
B07	008	3/4/81	Painter/Auxiliary	2	405	0.017	0.02	1	1
B70	008	3/5/81	Painter/Auxiliary	2	424	0.015	<0.01	< 0.7	< 0.6
B09	007	3/3/81	Painter/Containment	2	319	0.012	0.04	3	2
B17	010	3/3/81	Painter/Containment	2	306	0.016	<0.01	< 0.6	< 0.4
B31	009	3/4/81	Painter/Containment	1,2	342	0.015	0.03	2	1
B35	004	3/4/81	Painter/Containment	2	318	0.014	<0.01	< 0.7	< 0.5
B11	005	3/4/81	Painter/Containment	2	344	0.014	<0.01	< 0.7	< 0.5
B18	N.R.*	3/5/81	Painter/Containment	N.R.*	122	0.005	<0.01	< 2	***
B64	N.R.*	3/5/81	Painter/Containment	N.R.*	417	0.018	<0.01	< 0.6	< 0.5
B60	002	3/4/81	Painter/ESF**	1	405	0.014	0.17	12	10
B44	002	3/5/81	Painter/ESF**	1	230	0.010	0.07	7	--
B04	002	3/5/81	Painter/ESF**	1	156	0.006	0.01	2	4
B01	003	3/4/81	Painter/ESF**	1	185	0.010	0.08	8	--
B25	003	3/4/81	Painter/ESF**	1	151	0.004	0.04	10	6.2
B24	003	3/5/81	Painter/ESF**	1	218	0.007	<0.01	< 1	--
B34	003	3/5/81	Painter/ESF**	1	152	0.007	0.06	9	3

* Not Recorded
** Engineered Safety Features Building
*** No 8-TWA determined due to insufficient sample period.
1 Activity: 1-Compressed Air Spray Painting; 2) Brush Painting; 3) Roller Painting; 4) Power Brush
2 Non-detectable values were reported as less than (<) the detection limit. The limit of detection for 2EEA was 0.01 milligrams (mg) per sample.
3 Exposure during the 8-hour time period not sampled was assumed to be zero.
4 In cases where 1) determination of the 8-TWA involves consideration of more than one sample obtained during the 8-hour time period, and where 2) one or more of the sample concentrations was reported as less than the detection limit, a value of 50% of the "less than" sample concentration was used in the determination. The 8-TWA thus determined is a finite value.

TABLE B-7 SAMPLING RESULTS: TOTAL CHROMIUM
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3]
M52359	001	3/4/81	Mixer/Paint Shop	--	51	0.102	0.011	0.11	--
M52350	001	3/4/81	Mixer/Paint Shop	--	223	0.446	0.011	0.022	--
M53464	001	3/4/81	Mixer/Paint Shop	--	159	0.318	0.043	0.14	0.068
M52458	013	3/3/81	Painter/Turbine	4	105	0.210	0.019	0.090	--
M52459	013	3/3/81	Painter/Turbine	4	158	0.316	0.034	0.11	0.055
M52341	013	3/4/81	Painter/Turbine	4	148	0.296	0.140	0.472	--
M52346	013	3/4/81	Painter/Turbine	4	29	0.058	0.021	0.36	--
M53457	013	3/4/81	Painter/Turbine	4	151	0.302	0.220	0.728	0.40
M53463	N.R.*	3/5/81	Painter/Turbine	4	219	0.438	0.130	0.297	--
M53467	N.R.*	3/5/81	Painter/Turbine	4	162	0.324	0.069	0.21	0.21
M52455	012	3/3/81	Painter/Containment	4	146	0.292	0.018	0.062	--
M52457	012	3/3/81	Painter/Containment	4	102	0.204	0.013	0.063	--
M51622	012	3/3/81	Painter/Containment	4	47	0.094	0.013	0.14	0.045
M52354	012	3/4/81	Painter/Containment	4	167	0.334	0.014	0.042	--
M52363	012	3/4/81	Painter/Containment	4	201	0.402	0.016	0.040	0.031
M53462	009	3/4/81	Painter/Containment	4	127	0.254	0.110	0.433	--
M53460	009	3/4/81	Painter/Containment	4	175	0.350	0.350	1.00	--
M53452	009	3/4/81	Painter/Containment	4	114	0.228	1.800	7.89	2.35
M53450	N.R.*	3/5/81	Painter/Containment	4	52	0.104	0.013	0.13	--
M53447	N.R.*	3/5/81	Painter/Containment	4	268	0.536	0.026	0.048	--
M53365	N.R.*	3/5/81	Painter/Containment	4	98	0.196	0.015	0.077	0.056
M52456	003	3/3/81	Painter/Auxiliary	4	65	0.130	0.009	0.07	--
M52460	003	3/3/81	Painter/Auxiliary	4	84	0.168	0.009	0.05	--
M51217	003	3/3/81	Painter/Auxiliary	4	51	0.102	0.010	0.098	0.03
M52351	011	3/5/81	Painter/Auxiliary	4	150	0.300	0.010	0.033	--
M52344	011	3/5/81	Painter/Auxiliary	4	269	0.538	0.018	0.033	0.028
M53465	N.R.*	3/5/81	Painter/Auxiliary	4	120	0.240	0.034	0.14	--
M53446	N.R.*	3/5/81	Painter/Auxiliary	4	302	0.604	0.015	0.015	0.050

TABLE B-7 SAMPLING RESULTS: TOTAL CHROMIUM (CONT.)
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3]
M52345	002	3/4/81	Painter/ESF**	1	203	0.406	0.015	0.036	--
M53468	002	3/4/81	Painter/ESF**	1	151	0.302	0.014	0.046	0.030
M52360	003	3/4/81	Painter/ESF**	1	206	0.412	0.013	0.032	--
M53459	003	3/4/81	Painter/ESF**	1	148	0.296	0.012	0.041	0.026
M53466	N.R.*	3/5/81	Painter/ESF**	1	101	0.202	0.012	0.059	--
M53461	N.R.*	3/5/81	Painter/ESF**	1	115	0.230	0.011	0.048	--
M53456	N.R.*	3/5/81	Painter/ESF**	1	152	0.304	0.011	0.036	0.035
M53454	N.R.*	3/5/81	Painter/ESF**	1	109	0.218	0.011	0.050	--
M53458	N.R.*	3/5/81	Painter/ESF**	1	121	0.242	0.011	0.045	--
M53455	N.R.*	3/5/81	Painter/ESF**	1	156	0.312	0.011	0.035	0.033

* Not Recorded
** Engineered Safety Features Building
1 Activity: 1-Compressed Air Spray Painting; 2) Brush Painting; 3) Roller Painting; 4) Power Brush
2 Non-detectable values were reported as less than (<) the detection limit. The limit of detection for Total Chromium was 5 micrograms (ug) per sample.
3 Exposure during the 8-hour time period not sampled was assumed to be zero.

TABLE B-8 SAMPLING RESULTS: IRON
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3]
M52359	001	3/4/81	Mixer/Paint Shop	--	51	0.102	0.045	0.49	--
M52350	001	3/4/81	Mixer/Paint Shop	--	223	0.446	0.240	0.538	--
M53464	001	3/4/81	Mixer/Paint Shop	--	159	0.318	18.000	56.6	19.0
M52458	013	3/3/81	Painter/Turbine	4	105	0.210	14.000	66.7	--
M52459	013	3/3/81	Painter/Turbine	4	158	0.316	23.000	72.8	38.6
M52341	013	3/4/81	Painter/Turbine	4	148	0.296	73.000	247	--
M52346	013	3/4/81	Painter/Turbine	4	29	0.058	7.000	121	--
M53457	013	3/4/81	Painter/Turbine	4	151	0.302	120.000	397	209
M53463	N.R.*	3/5/81	Painter/Turbine	4	219	0.438	69.000	158	--
M53467	N.R.*	3/5/81	Painter/Turbine	4	162	0.324	38.000	117	112
M52455	012	3/3/81	Painter/Containment	4	146	0.292	1.000	3.42	--
M52457	012	3/3/81	Painter/Containment	4	102	0.204	0.550	2.70	--
M51622	012	3/3/81	Painter/Containment	4	47	0.094	0.220	2.34	1.84
M52354	012	3/4/81	Painter/Containment	4	167	0.334	0.970	2.90	--
M52363	012	3/4/81	Painter/Containment	4	201	0.402	1.400	3.48	2.47
M53462	009	3/4/81	Painter/Containment	4	127	0.254	13.000	51.2	--
M53460	009	3/4/81	Painter/Containment	4	175	0.350	26.000	74.3	--
M53452	009	3/4/81	Painter/Containment	4	114	0.228	140.000	614	186
M53450	N.R.*	3/5/81	Painter/Containment	4	52	0.104	0.740	7.12	--
M53447	N.R.*	3/5/81	Painter/Containment	4	268	0.536	4.100	7.65	--
M53365	N.R.*	3/5/81	Painter/Containment	4	98	0.196	0.630	3.21	5.70
M52456	003	3/3/81	Painter/Auxiliary	4	65	0.130	0.390	3.00	--
M52460	003	3/3/81	Painter/Auxiliary	4	84	0.168	0.340	2.02	--
M51217	003	3/3/81	Painter/Auxiliary	4	51	0.102	0.280	2.75	1.17
M52351	011	3/5/81	Painter/Auxiliary	4	150	0.300	0.540	1.80	--
M52344	011	3/5/81	Painter/Auxiliary	4	269	0.538	1.500	2.79	2.13
M53465	N.R.*	3/5/81	Painter/Auxiliary	4	120	0.240	7.000	29.2	--
M53446	N.R.*	3/5/81	Painter/Auxiliary	4	302	0.604	2.300	3.81	9.70

TABLE B-8 SAMPLING RESULTS: IRON (CONT.)
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3]
M52345	002	3/4/81	Painter/ESF**	1	203	0.406	0.110	0.271	--
M53468	002	3/4/81	Painter/ESF**	1	151	0.302	0.110	0.364	0.229
M52360	003	3/4/81	Painter/ESF**	1	206	0.412	0.140	0.340	--
M53459	003	3/4/81	Painter/ESF**	1	148	0.296	0.098	0.33	0.26
M53466	N.R.*	3/5/81	Painter/ESF**	1	101	0.202	0.083	0.41	--
M53461	N.R.*	3/5/81	Painter/ESF**	1	115	0.230	0.090	0.39	--
M53456	N.R.*	3/5/81	Painter/ESF**	1	152	0.304	0.071	0.23	0.25
M53454	N.R.*	3/5/81	Painter/ESF**	1	109	0.218	0.083	0.38	--
M53458	N.R.*	3/5/81	Painter/ESF**	1	121	0.242	0.090	0.37	--
M53455	N.R.*	3/5/81	Painter/ESF**	1	156	0.312	0.060	0.21	0.25

* Not Recorded
** Engineered Safety Features Building
1 Activity: 1-Compressed Air Spray Painting; 2) Brush Painting; 3) Roller Painting; 4) Power Brush
2 Non-detectable values were reported as less than (<) the detection limit. The limit of detection for Iron was 3 micrograms (ug) per sample.
3 Exposure during the 8-hour time period not sampled was assumed to be zero.

TABLE B-9 SAMPLING RESULTS: MANGANESE
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3]
M52359	001	3/4/81	Mixer/Paint Shop	--	51	0.102	0.002	0.02	--
M52350	001	3/4/81	Mixer/Paint Shop	--	223	0.446	0.002	0.005	--
M53464	001	3/4/81	Mixer/Paint Shop	--	159	0.318	0.130	0.409	0.14
M52458	013	3/3/81	Painter/Turbine	4	105	0.210	0.080	0.38	--
M52459	013	3/3/81	Painter/Turbine	4	158	0.316	0.150	0.475	0.24
M52341	013	3/4/81	Painter/Turbine	4	148	0.296	0.660	2.23	--
M52346	013	3/4/81	Painter/Turbine	4	29	0.058	0.042	6.90	--
M53457	013	3/4/81	Painter/Turbine	4	151	0.302	1.100	3.64	1.88
M53463	N.R.*	3/5/81	Painter/Turbine	4	219	0.438	0.500	1.14	--
M53467	N.R.*	3/5/81	Painter/Turbine	4	162	0.324	0.280	0.864	0.811
M52455	012	3/3/81	Painter/Containment	4	146	0.292	0.013	0.045	--
M52457	012	3/3/81	Painter/Containment	4	102	0.204	0.008	0.039	--
M51622	012	3/3/81	Painter/Containment	4	47	0.094	0.003	0.032	0.025
M52354	012	3/4/81	Painter/Containment	4	167	0.334	0.011	0.033	--
M52363	012	3/4/81	Painter/Containment	4	201	0.402	0.016	0.040	0.028
M53462	009	3/4/81	Painter/Containment	4	127	0.254	0.100	0.394	--
M53460	009	3/4/81	Painter/Containment	4	175	0.350	0.240	0.674	--
M53452	009	3/4/81	Painter/Containment	4	114	0.228	1.700	7.46	2.12
M53450	N.R.*	3/5/81	Painter/Containment	4	52	0.104	0.007	0.07	--
M53447	N.R.*	3/5/81	Painter/Containment	4	268	0.536	0.038	0.07	--
M53365	N.R.*	3/5/81	Painter/Containment	4	98	0.196	0.009	0.05	0.06
M52456	003	3/3/81	Painter/Auxiliary	4	65	0.130	0.003	0.02	--
M52460	003	3/3/81	Painter/Auxiliary	4	84	0.168	0.003	0.02	--
M51217	003	3/3/81	Painter/Auxiliary	4	51	0.102	0.002	0.02	0.01
M52351	011	3/5/81	Painter/Auxiliary	4	150	0.300	0.005	0.02	--
M52344	011	3/5/81	Painter/Auxiliary	4	269	0.538	0.017	0.032	0.02
M53465	N.R.*	3/5/81	Painter/Auxiliary	4	120	0.240	0.046	0.19	--
M53446	N.R.*	3/5/81	Painter/Auxiliary	4	302	0.604	0.023	0.038	0.071

TABLE B-9 SAMPLING RESULTS: MANGANESE (CONT.)
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3]
M52345	002	3/4/81	Painter/ESF**	1	203	0.406	<0.002	<0.005	--
M53468	002	3/4/81	Painter/ESF**	1	151	0.302	<0.002	<0.006	0.002
M52360	003	3/4/81	Painter/ESF**	1	206	0.412	0.002	0.005	--
M53459	003	3/4/81	Painter/ESF**	1	148	0.296	<0.002	<0.007	0.003
M53466	N.R.*	3/4/81	Painter/ESF**	1	101	0.202	<0.002	<0.01	--
M53461	N.R.*	3/4/81	Painter/ESF**	1	115	0.230	<0.002	<0.009	--
M53456	N.R.*	3/4/81	Painter/ESF**	1	152	0.304	0.003	0.01	0.005
M53454	N.R.*	3/4/81	Painter/ESF**	1	109	0.218	<0.002	<0.009	--
M53458	N.R.*	3/4/81	Painter/ESF**	1	121	0.242	<0.002	<0.008	--
M53455	N.R.*	3/4/81	Painter/ESF**	1	156	0.312	<0.002	<0.006	0.003

* Not Recorded
** Engineered Safety Features Building
1 Activity: 1-Compressed Air Spray Painting; 2) Brush Painting; 3) Roller Painting; 4) Power Brush
2 Non-detectable values were reported as less than (<) the detection limit. The limit of detection for Manganese was 2 micrograms (ug) per sample.
3 Exposure during the 8-hour time period not sampled was assumed to be zero.
4 In cases where 1) determination of the 8-TWA involves consideration of more than one sample obtained during the 8-hour time period and where 2) one or more of the sample concentrations was reported as less than the detection limit, a value of 50% of the "less than" sample concentration was used in the determination. The 8-TWA thus determined is a finite value.

TABLE B-10 SAMPLING RESULTS: LEAD
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3]
M52359	001	3/4/81	Mixer/Paint Shop	--	51	0.102	<0.003	<0.03	--
M52350	001	3/4/81	Mixer/Paint Shop	--	223	0.446	0.007	0.02	--
M53464	001	3/4/81	Mixer/Paint Shop	--	159	0.318	0.320	1.01	0.35
M52458	013	3/3/81	Painter/Turbine	4	105	0.210	0.710	3.38	--
M52459	013	3/3/81	Painter/Turbine	4	158	0.316	0.740	2.36	1.52
M52341	013	3/4/81	Painter/Turbine	4	148	0.296	2.500	8.50	--
M52346	013	3/4/81	Painter/Turbine	4	29	0.058	0.240	4.14	--
M53457	013	3/4/81	Painter/Turbine	4	151	0.302	3.100	10.3	6.11
M53463	N.R.*	3/5/81	Painter/Turbine	4	219	0.438	5.900	13.5	--
M53467	N.R.*	3/5/81	Painter/Turbine	4	162	0.324	1.600	4.94	7.82
M52455	012	3/3/81	Painter/Containment	4	146	0.292	0.023	0.079	--
M52457	012	3/3/81	Painter/Containment	4	102	0.204	0.013	0.064	--
M51622	012	3/3/81	Painter/Containment	4	47	0.094	<0.003	<0.03	0.039
M52354	012	3/4/81	Painter/Containment	4	167	0.334	0.009	0.03	--
M52363	012	3/4/81	Painter/Containment	4	201	0.402	0.020	0.050	0.03
M53462	009	3/4/81	Painter/Containment	4	127	0.254	0.930	3.60	--
M53460	009	3/4/81	Painter/Containment	4	175	0.350	4.900	14.0	--
M53452	009	3/4/81	Painter/Containment	4	114	0.228	14.000	61.4	20.6
M53450	N.R.*	3/5/81	Painter/Containment	4	52	0.104	0.009	0.09	--
M53447	N.R.*	3/5/81	Painter/Containment	4	268	0.536	0.040	0.07	--
M53365	N.R.*	3/5/81	Painter/Containment	4	98	0.196	0.009	0.05	0.06
M52456	003	3/3/81	Painter/Auxiliary	4	65	0.130	0.200	1.54	--
M52460	003	3/3/81	Painter/Auxiliary	4	84	0.168	0.110	0.655	--
M51217	003	3/3/81	Painter/Auxiliary	4	51	0.102	0.044	0.43	0.37
M52351	011	3/5/81	Painter/Auxiliary	4	150	0.300	0.150	0.500	--
M52344	011	3/5/81	Painter/Auxiliary	4	269	0.538	1.200	2.23	1.40
M53465	N.R.*	3/5/81	Painter/Auxiliary	4	120	0.240	0.140	0.579	--
M53446	N.R.*	3/5/81	Painter/Auxiliary	4	302	0.604	0.046	0.076	0.19

TABLE B-10 SAMPLING RESULTS: LEAD (CONT.)
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3]
M52345	002	3/4/81	Painter/ESF**	1	203	0.406	0.007	0.02	--
M53468	002	3/4/81	Painter/ESF**	1	151	0.302	0.005	0.02	0.01
M52360	003	3/4/81	Painter/ESF**	1	206	0.412	0.019	0.05	--
M53459	003	3/4/81	Painter/ESF**	1	148	0.296	0.004	0.01	0.02
M53466	N.R.*	3/4/81	Painter/ESF**	1	101	0.202	0.003	0.01	--
M53461	N.R.*	3/4/81	Painter/ESF**	1	115	0.230	0.008	0.03	--
M53456	N.R.*	3/4/81	Painter/ESF**	1	152	0.304	0.004	0.01	0.01
M53454	N.R.*	3/4/81	Painter/ESF**	1	109	0.218	<0.003	<0.01	--
M53458	N.R.*	3/4/81	Painter/ESF**	1	121	0.242	<0.003	<0.01	--
M53455	N.R.*	3/4/81	Painter/ESF**	1	156	0.312	<0.003	<0.01	0.004

* Not Recorded
** Engineered Safety Features Building
1 Activity: 1-Compressed Air Spray Painting; 2) Brush Painting; 3) Roller Painting; 4) Power Brush
2 Non-detectable values were reported as less than (<) the detection limit. The limit of detection for Lead was 3 micrograms (ug) per sample.
3 Exposure during the 8-hour time period not sampled was assumed to be zero.
4 In cases where 1) determination of the 8-TWA involves consideration of more than one sample obtained during the 8-hour time period and where 2) one or more of the sample concentrations was reported as less than the detection limit, a value of 50% of the "less than" sample concentration was used in the determination. The 8-TWA thus determined is a finite value.

TABLE B-11 SAMPLING RESULTS: ZINC
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3]
M52359	001	3/4/81	Mixer/Paint Shop	--	51	0.102	<0.002	<0.02	--
M52350	001	3/4/81	Mixer/Paint Shop	--	223	0.446	0.007	0.02	--
M53464	001	3/4/81	Mixer/Paint Shop	--	159	0.318	0.047	0.15	0.06
M52458	013	3/3/81	Painter/Turbine	4	105	0.210	0.070	0.33	--
M52459	013	3/3/81	Painter/Turbine	4	158	0.316	0.063	0.20	0.14
M52341	013	3/4/81	Painter/Turbine	4	148	0.296	0.230	0.777	--
M52346	013	3/4/81	Painter/Turbine	4	29	0.058	0.008	0.1	--
M53457	013	3/4/81	Painter/Turbine	4	151	0.302	0.280	0.927	0.54
M53463	N.R.*	3/5/81	Painter/Turbine	4	219	0.438	0.280	0.639	--
M53467	N.R.*	3/5/81	Painter/Turbine	4	162	0.324	0.180	0.556	0.479
M52455	012	3/3/81	Painter/Containment	4	146	0.292	0.300	1.03	--
M52457	012	3/3/81	Painter/Containment	4	102	0.204	0.280	1.37	--
M51622	012	3/3/81	Painter/Containment	4	47	0.094	0.059	0.63	0.67
M52354	012	3/4/81	Painter/Containment	4	167	0.334	1.300	3.89	--
M52363	012	3/4/81	Painter/Containment	4	201	0.402	3.100	7.71	4.58
M53462	009	3/4/81	Painter/Containment	4	127	0.254	0.063	0.25	--
M53460	009	3/4/81	Painter/Containment	4	175	0.350	0.500	1.43	--
M53452	009	3/4/81	Painter/Containment	4	114	0.228	3.300	14.5	4.0
M53450	N.R.*	3/5/81	Painter/Containment	4	52	0.104	0.460	4.42	--
M53447	N.R.*	3/5/81	Painter/Containment	4	268	0.536	3.800	7.09	--
M53365	N.R.*	3/5/81	Painter/Containment	4	98	0.196	0.920	4.65	5.39
M52456	003	3/3/81	Painter/Auxiliary	4	65	0.130	<0.002	<0.02	--
M52460	003	3/3/81	Painter/Auxiliary	4	84	0.168	<0.002	<0.01	--
M51217	003	3/3/81	Painter/Auxiliary	4	51	0.102	<0.002	<0.02	0.003
M52351	011	3/5/81	Painter/Auxiliary	4	150	0.300	0.003	0.01	--
M52344	011	3/5/81	Painter/Auxiliary	4	269	0.538	0.008	0.01	0.008
M53465	N.R.*	3/5/81	Painter/Auxiliary	4	120	0.240	0.017	0.070	--
M53446	N.R.*	3/5/81	Painter/Auxiliary	4	302	0.604	0.012	0.020	0.025

TABLE B-11 SAMPLING RESULTS: ZINC (CONT.)
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3]
M52345	002	3/4/81	Painter/ESF**	1	203	0.406	0.006	0.01	--
M53468	002	3/4/81	Painter/ESF**	1	151	0.302	0.003	0.01	0.007
M52360	003	3/4/81	Painter/ESF**	1	206	0.412	0.007	0.02	--
M53459	003	3/4/81	Painter/ESF**	1	148	0.296	0.007	0.02	0.01
M53466	N.R.*	3/4/81	Painter/ESF**	1	101	0.202	0.022	0.11	--
M53461	N.R.*	3/4/81	Painter/ESF**	1	115	0.230	<0.002	<0.009	--
M53456	N.R.*	3/4/81	Painter/ESF**	1	152	0.304	<0.002	<0.007	0.02
M53454	N.R.*	3/4/81	Painter/ESF**	1	109	0.218	0.022	0.10	--
M53458	N.R.*	3/4/81	Painter/ESF**	1	121	0.242	<0.002	<0.008	--
M53455	N.R.*	3/4/81	Painter/ESF**	1	156	0.312	<0.002	<0.006	0.02

* Not Recorded
** Engineered Safety Features Building
1 Activity: 1-Compressed Air Spray Painting; 2) Brush Painting; 3) Roller Painting; 4) Power Brush
2 Non-detectable values were reported as less than (<) the detection limit. The limit of detection for Zinc was 2 micrograms (ug) per sample.
3 Exposure during the 8-hour time period not sampled was assumed to be zero.
4 In cases where 1) determination of the 8-TWA involves consideration of more than one sample obtained during the 8-hour time period and where 2) one or more of the sample concentrations was reported as less than the detection limit, a value of 50% of the "less than" sample concentration was used in the determination. The 8-TWA thus determined is a finite value.

TABLE B-12 SAMPLING RESULTS: NUISANCE (TOTAL) DUST
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3]
M52359	001	3/4/81	Mixer/Paint Shop	--	51	0.102	0.08	0.8	--
M52350	001	3/4/81	Mixer/Paint Shop	--	223	0.446	2.16	4.84	--
M53464	001	3/4/81	Mixer/Paint Shop	--	159	0.318	37.09	85.2	30
M52458	013	3/3/81	Painter/Turbine	4	105	0.210	29.06	138	--
M52459	013	3/3/81	Painter/Turbine	4	158	0.316	51.08	162	83.5
M52341	013	3/4/81	Painter/Turbine	4	148	0.296	151.35	511	--
M52346	013	3/4/81	Painter/Turbine	4	29	0.058	12.40	214	--
M53457	013	3/4/81	Painter/Turbine	4	151	0.302	245.40	813	427
M53463	N.R.*	3/5/81	Painter/Turbine	4	219	0.438	174.37	336	--
M53467	N.R.*	3/5/81	Painter/Turbine	4	162	0.324	76.94	237	233
M52455	012	3/3/81	Painter/Containment	4	146	0.292	8.74	29.9	--
M52457	012	3/3/81	Painter/Containment	4	102	0.204	4.95	24.3	--
M51622	012	3/3/81	Painter/Containment	4	47	0.094	1.35	144	16.6
M52354	012	3/4/81	Painter/Containment	4	167	0.334	9.19	275	--
M52363	012	3/4/81	Painter/Containment	4	201	0.402	18.45	459	28.7
M53462	009	3/4/81	Painter/Containment	4	127	0.254	66.86	259	--
M53460	009	3/4/81	Painter/Containment	4	175	0.350	194.94	557	--
M53452	009	3/4/81	Painter/Containment	4	114	0.228	700.04	3070	1000
M53450	N.R.*	3/5/81	Painter/Containment	4	52	0.104	6.20	59.6	--
M53447	N.R.*	3/5/81	Painter/Containment	4	268	0.536	33.96	63.4	--
M53365	N.R.*	3/5/81	Painter/Containment	4	98	0.196	7.34	37.4	49.4
M52456	003	3/3/81	Painter/Auxiliary	4	65	0.130	5.05	38.8	--
M52460	003	3/3/81	Painter/Auxiliary	4	84	0.168	4.10	24.4	--
M51217	003	3/3/81	Painter/Auxiliary	4	51	0.102	2.38	23.3	11.9
M52351	011	3/5/81	Painter/Auxiliary	4	150	0.300	4.45	14.8	--
M52344	011	3/5/81	Painter/Auxiliary	4	269	0.538	24.80	46.1	30.4
M53465	N.R.*	3/5/81	Painter/Auxiliary	4	120	0.240	26.50	110	--
M53446	N.R.*	3/5/81	Painter/Auxiliary	4	302	0.604	14.54	24.1	42.6

TABLE B-12 SAMPLING RESULTS: NUISANCE (TOTAL) DUST (CONT.)
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

SAMPLE NUMBER	PERSON CODE	DATE	JOB TITLE/ LOCATION	ACTIVITY[1]	SAMPLE TIME (min)	SAMPLE VOLUME (m^3)	ANALYTICAL RESULTS (mg/sample)[2]	CONCENTRATION (mg/m^3)	8-HOUR TWA (mg/m^3)[3]
M52345	002	3/4/81	Painter/ESF**	1	203	0.406	18.38	45.3	--
M53468	002	3/4/81	Painter/ESF**	1	151	0.302	17.17	56.8	37.0
M52360	003	3/4/81	Painter/ESF**	1	206	0.412	27.20	66.0	--
M53459	003	3/4/81	Painter/ESF**	1	148	0.296	12.41	41.9	41.2
M53466	N.R.*	3/4/81	Painter/ESF**	1	101	0.202	11.42	56.5	--
M53461	N.R.*	3/4/81	Painter/ESF**	1	115	0.230	2.33	11.7	--
M53456	N.R.*	3/4/81	Painter/ESF**	1	152	0.304	2.31	7.60	17.0
M53454	N.R.*	3/4/81	Painter/ESF**	1	109	0.218	11.17	51.2	--
M53458	N.R.*	3/4/81	Painter/ESF**	1	121	0.242	1.81	7.48	--
M53455	N.R.*	3/4/81	Painter/ESF**	1	156	0.312	5.20	16.7	18.9

* Not Recorded
** Engineered Safety Features Building
1 Activity: 1-Compressed Air Spray Painting; 2) Brush Painting; 3) Roller Painting; 4) Power Brush
2 Non-detectable values were reported as less than (<) the detection limit. The limit of detection for Nuisance (Total) Dust was 0.01 milligrams (mg) per sample.
3 Exposure during the 8-hour time period not sampled was assumed to be zero.

APPENDIX C

DESCRIPTIVE STATISTICS, GROUPED EXPOSURE DATA
TABLES C1 to C12

C-1 DESCRIPTIVE STATISTICS BY AREA/JOB: TOLUENE
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

JOB TITLE/ LOCATION	NUMBER OF 8-TWAs	NUMBER OF EMPLOYEES SAMPLED	MAXIMUM mg/m^3	MINIMUM mg/m^3	GEOMETRIC MEAN mg/m^3	GEOMETRIC STANDARD DEVIATION	95%[1] LCL	95%[2] UCL
Mixer/Paint Shop	2	1	2	**	**	**	**	**
Painter/Turbine	3	2***	0.3	**	**	**	**	**
Painter/Auxiliary	2	1	0.25	**	**	**	**	**
Painter/Containment	6	5***	2	**	**	**	**	**
Painter/ESF*	4	2	2	**	**	**	**	**

* Engineered Safety Features Building
** No statistical analysis performed since greater than 50% of reported Concentrations were less than the limit of detection.
*** Number could be greater depending upon identity of individual(s) whose name(s) was (were) not recorded.
1 95% Lower Confidence Limit
2 95% Upper Confidence Limit

C-2 DESCRIPTIVE STATISTICS BY AREA/JOB: XYLENE
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

JOB TITLE/ LOCATION	NUMBER OF 8-TWAs	NUMBER OF EMPLOYEES SAMPLED	MAXIMUM mg/m^3	MINIMUM mg/m^3	GEOMETRIC MEAN mg/m^3	GEOMETRIC STANDARD DEVIATION	95%[1] LCL	95%[2] UCL
Mixer/Paint Shop	2	1	6	**	**	**	**	**
Painter/Turbine	3	2***	1	1	1	1	1	1
Painter/Auxiliary	2	1	108	4.7	22.5	9.17	0.00	1.00×10^{10}
Painter/Containment	6	5***	12	1	3.8	2.2	1.6	8.7
Painter/ESF*	4	2	52	16	33	1.7	15	75

* Engineered Safety Features Building
** No statistical analysis performed since greater than 50% of reported Concentrations were less than the limit of detection.
*** Number could be greater depending upon identity of individual(s) whose name(s) was (were) not recorded.
1 95% Lower Confidence Limit
2 95% Upper Confidence Limit

C-3 DESCRIPTIVE STATISTICS BY AREA/JOB: BUTYL ACETATE
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

JOB TITLE/ LOCATION	NUMBER OF 8-TWAs	NUMBER OF EMPLOYEES SAMPLED	MAXIMUM mg/m^3	MINIMUM mg/m^3	GEOMETRIC MEAN mg/m^3	GEOMETRIC STANDARD DEVIATION	95%[1] LCL	95%[2] UCL
Mixer/Paint Shop	2	1	3	0.9	2	2.3	0.00	$3x10^3$
Painter/Turbine	3	2***	0.3	**	**	**	**	**
Painter/Auxiliary	2	1	33	16	23	1.7	0.23	$2.3x10^3$
Painter/Containment	6	5***	18	0.2	1.8	6.8	0.25	14
Painter/ESF*	4	2	73	25	47	1.6	22	$1.0x10^2$

* Engineered Safety Features Building
** No statistical analysis performed since greater than 50% of reported Concentrations were less than the limit of detection.
*** Number could be greater depending upon identity of individual(s) whose name(s) was (were) not recorded.
1 95% Lower Confidence Limit
2 95% Upper Confidence Limit

C-4 DESCRIPTIVE STATISTICS BY AREA/JOB: SOLVESSO 100R (MINERAL SPIRITS)
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

JOB TITLE/ LOCATION	NUMBER OF 8-TWAs	NUMBER OF EMPLOYEES SAMPLED	MAXIMUM mg/m^3	MINIMUM mg/m^3	GEOMETRIC MEAN mg/m^3	GEOMETRIC STANDARD DEVIATION	95%[1] LCL	95%[2] UCL
Mixer/Paint Shop	2	1	5	**	**	**	**	**
Painter/Turbine	3	2***	2	**	**	**	**	**
Painter/Auxiliary	2	1	5	4.7	4.8	1.0	3.3	7.2
Painter/Containment	6	5***	6.3	1	2.3	2.1	1.0	5.0
Painter/ESF*	4	2	47	17	29	1.6	13	64

* Engineered Safety Features Building
** No statistical analysis performed since greater than 50% of reported Concentrations were less than the limit of detection.
*** Number could be greater depending upon identity of individual(s) whose name(s) was (were) not recorded.
1 95% Lower Confidence Limit
2 95% Upper Confidence Limit

C-5 DESCRIPTIVE STATISTICS BY AREA/JOB: 2-ETHOXYETHANOL (2EE)
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

JOB TITLE/ LOCATION	NUMBER OF 8-TWAs	NUMBER OF EMPLOYEES SAMPLED	MAXIMUM mg/m^3	MINIMUM mg/m^3	GEOMETRIC MEAN mg/m^3	GEOMETRIC STANDARD DEVIATION	95%[1] LCL	95%[2] UCL
Mixer/Paint Shop	2	1	2	2	2	2	2	2
Painter/Turbine	3	2***	0.35	**	**	**	**	**
Painter/Auxiliary	2	1	20	7.9	13	1.9	0.03	4.6×10^3
Painter/Containment	6	5***	11	0.2	1.2	5.2	0.2	6.9
Painter/ESF*	4	2	72	14	33	2.0	11	97

* Engineered Safety Features Building
** No statistical analysis performed since greater than 50% of reported Concentrations were less than the limit of detection.
*** Number could be greater depending upon identity of individual(s) whose name(s) was (were) not recorded.
1 95% Lower Confidence Limit
2 95% Upper Confidence Limit

C-6 DESCRIPTIVE STATISTICS BY AREA/JOB: 2-ETHOXYETHYL ACETATE (2EEA)
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

JOB TITLE/ LOCATION	NUMBER OF 8-TWAs	NUMBER OF EMPLOYEES SAMPLED	MAXIMUM mg/m^3	MINIMUM mg/m^3	GEOMETRIC MEAN mg/m^3	GEOMETRIC STANDARD DEVIATION	95%[1] LCL	95%[2] UCL
Mixer/Paint Shop	2	1	11	**	**	**	**	**
Painter/Turbine	3	2***	0.35	**	**	**	**	**
Painter/Auxiliary	2	1	1	**	**	**	**	**
Painter/Containment	6	5***	2	**	**	**	**	**
Painter/ESF*	4	2	10	3	5.2	1.7	2.3	12

* Engineered Safety Features Building
** No statistical analysis performed since greater than 50% of reported Concentrations were less than the limit of detection.
*** Number could be greater depending upon identity of individual(s) whose name(s) was (were) not recorded.
1 95% Lower Confidence Limit
2 95% Upper Confidence Limit

C-7 DESCRIPTIVE STATISTICS BY AREA/JOB: TOTAL CHROMIUM
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

JOB TITLE/ LOCATION	NUMBER OF 8-TWAs	NUMBER OF EMPLOYEES SAMPLED	MAXIMUM mg/m^3	MINIMUM mg/m^3	GEOMETRIC MEAN mg/m^3	GEOMETRIC STANDARD DEVIATION	95%[1] LCL	95%[2] UCL
Mixer/Paint Shop	1	1	0.068	-	-	-	-	-
Painter/Turbine	3	1**	0.40	0.055	0.17	2.8	0.01	2.1
Painter/Auxiliary	3	2**	0.050	0.028	0.035	1.4	0.02	0.08
Painter/Containment	4	2**	2.35	0.031	0.12	7.5	0.00	2.9
Painter/ESF*	4	2**	0.035	0.026	0.03	1.1	0.03	0.04

* Engineered Safety Features Building
** Number could be greater depending upon identity of individual(s) whose name(s) was (were) not recorded.
1 95% Lower Confidence Limit
2 95% Upper Confidence Limit

C-8 DESCRIPTIVE STATISTICS BY AREA/JOB: IRON
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

JOB TITLE/ LOCATION	NUMBER OF 8-TWAs	NUMBER OF EMPLOYEES SAMPLED	MAXIMUM mg/m^3	MINIMUM mg/m^3	GEOMETRIC MEAN mg/m^3	GEOMETRIC STANDARD DEVIATION	95%[1] LCL	95%[2] UCL
Mixer/Paint Shop	1	1	19.0	-	-	-	-	-
Painter/Turbine	3	1**	209	38.6	96.7	2.35	11.6	807
Painter/Auxiliary	3	2**	2.39	1.17	1.81	1.47	0.70	4.07
Painter/Containment	4	2**	186	1.84	8.33	8.37	0.28	2.45
Painter/ESF*	4	2**	0.26	0.229	0.25	1.06	0.23	0.27

* Engineered Safety Features Building
** Number could be greater depending upon identity of individual(s) whose name(s) was (were) not recorded.
1 95% Lower Confidence Limit
2 95% Upper Confidence Limit

C-9 DESCRIPTIVE STATISTICS BY AREA/JOB: MANGANESE
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

JOB TITLE/ LOCATION	NUMBER OF 8-TWAs	NUMBER OF EMPLOYEES SAMPLED	MAXIMUM mg/m^3	MINIMUM mg/m^3	GEOMETRIC MEAN mg/m^3	GEOMETRIC STANDARD DEVIATION	95%[1] LCL	95%[2] UCL
Mixer/Paint Shop	1	1	0.14	-	-	-	-	-
Painter/Turbine	3	1**	1.88	0.24	0.72	2.8	0.05	9.4
Painter/Auxiliary	3	2**	0.071	0.01	0.02	2.7	0.00	0.29
Painter/Containment	4	2**	2.12	0.025	0.10	8.1	0.00	2.7
Painter/ESF*	4	2**	0.005	***	***	***	***	***

* Engineered Safety Features Building
** Number could be greater depending upon identity of individual(s) whose name(s) was (were) not recorded.
*** No statistical analysis performed since greater than 50% of reported Concentrations were less than the limit of detection.
1 95% Lower Confidence Limit
2 95% Upper Confidence Limit

C-10 DESCRIPTIVE STATISTICS BY AREA/JOB: LEAD
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

JOB TITLE/ LOCATION	NUMBER OF 8-TWAs	NUMBER OF EMPLOYEES SAMPLED	MAXIMUM mg/m^3	MINIMUM mg/m^3	GEOMETRIC MEAN mg/m^3	GEOMETRIC STANDARD DEVIATION	95%[1] LCL	95%[2] UCL
Mixer/Paint Shop	1	1	0.35	-	-	-	-	-
Painter/Turbine	3	1**	7.82	1.52	4.17	2.42	0.47	37.4
Painter/Auxiliary	3	2**	1.40	0.19	0.46	2.8	0.04	5.8
Painter/Containment	4	2**	20.6	0.03	0.20	22.6	0.00	27.9
Painter/ESF*	4	2**	0.02	0.004	0.01	1.9	0.00	0.03

* Engineered Safety Features Building
** Number could be greater depending upon identity of individual(s) whose name(s) was (were) not recorded.
1 95% Lower Confidence Limit
2 95% Upper Confidence Limit

C-11 DESCRIPTIVE STATISTICS BY AREA/JOB: ZINC
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

JOB TITLE/ LOCATION	NUMBER OF 8-TWAs	NUMBER OF EMPLOYEES SAMPLED	MAXIMUM mg/m^3	MINIMUM mg/m^3	GEOMETRIC MEAN mg/m^3	GEOMETRIC STANDARD DEVIATION	95%[1] LCL	95%[2] UCL
Mixer/Paint Shop	1	1	0.06	-	-	-	-	-
Painter/Turbine	3	1**	0.54	0.14	0.33	2.1	0.05	2.1
Painter/Auxiliary	3	2**	0.025	0.003	0.01	2.9	0.00	0.12
Painter/Containment	4	2**	5.39	0.67	2.9	2.7	0.61	13
Painter/ESF*	4	2**	0.02	0.007	0.01	1.7	0.01	0.03

* Engineered Safety Features Building
** Number could be greater depending upon identity of individual(s) whose name(s) was (were) not recorded.
1 95% Lower Confidence Limit
2 95% Upper Confidence Limit

C-12 DESCRIPTIVE STATISTICS BY AREA/JOB: NUISANCE DUST
MILLSTONE NUCLEAR POWER STATION #3 - MARCH 3-5, 1981

JOB TITLE/ LOCATION	NUMBER OF 8-TWAs	NUMBER OF EMPLOYEES SAMPLED	MAXIMUM mg/m^3	MINIMUM mg/m^3	GEOMETRIC MEAN mg/m^3	GEOMETRIC STANDARD DEVIATION	95%[1] LCL	95%[2] UCL
Mixer/Paint Shop	1	1	30	-	-	-	-	-
Painter/Turbine	3	1**	427	83.5	203	2.3	26.1	1.60×10^3
Painter/Auxiliary	3	2**	42.6	11.9	24.9	1.94	4.82	129
Painter/Containment	4	2**	1000	16.6	69.7	6.24	3.78	1.30×10^3
Painter/ESF*	4	2**	41.2	17.0	26.5	1.57	12.9	54.5

* Engineered Safety Features Building
** Number could be greater depending upon identity of individual(s) whose name(s) was (were) not recorded.
1 95% Lower Confidence Limit
2 95% Upper Confidence Limit

APPENDIX D

TOTAL HYDROCARBON MEASUREMENTS

TABLE D-1
TOTAL HYDROCARBON MEASUREMENTS*
MILLSTONE NUCLEAR POWER STATION #3
MARCH 3-5, 1981

DATE	TIME	CONCENTRATION	ACTIVITY
3/4/81	12:30pm	200 ppm	Pouring solvent through hoses for cleaning, ESF building.
	12:35pm	150 ppm	Cleaning paint gun with solvent, ESF building
	1:45pm	50-150 ppm	Spray painting walls, ESF building
	1:45pm	200 ppm	Pouring paint into potn, ESF building
3/5/81	9:00am	105 ppm	Spray painting east wall, ESF building
	9:32am	150 ppm	Downstream of spray painter, ESF building
	9:33am	100 ppm	Behind spray painter - east wall, ESF building
	9:35am	45 ppm	South wall, ESF building
	9:36am	48 ppm	West wall, ESF building
	9:37am	50 ppm	North wall, ESF building
	9:38am	60 ppm	Center, ESF building
	10:00am	16 ppm	After break and after 5 minutes of spraying, ESF building
	10:05am	40-120 ppm	After break and after 5 minutes of spraying, ESF building
	10:10am	40- 50 ppm	Cleaning pot and gun with solvent, ESF building
	10:16am	80-160 ppm	Cleaning pot and gun with solvent, ESF building

TABLE D-1 (CONT.)
TOTAL HYDROCARBON MEASUREMENTS*
MILLSTONE NUCLEAR POWER STATION #3
MARCH 3-5, 1981

DATE	TIME	CONCENTRATION	ACTIVITY
	10:19am	50- 60 ppm	Cleaning pot and gun with solvent, ESF building
	10:25am	40 ppm	Reassembling gun (fan was reversed for blowing air into room), ESF building
	1:00pm	10 ppm	Mixing table, ESF building
	2:00pm	10 ppm	Mixing table, ESF building
	2:10pm	10 ppm	Mixing table, ESF building
3/5/81	2:25pm	10 ppm	Mixing table, ESF building
	2:40pm	10 ppm	Mixing table, ESF building
	2:50pm	10 ppm	Mixing table, ESF building
	3:15pm	10 ppm	Paint Shop, corner of paint booth
	3:25pm	10 ppm	Paint Shop, corner of paint booth
	4:15pm	10-20 ppm	Paint Shop, corner of paint booth

*HNU Photo Ionization Detector Scale Range (0-200 ppm)