IN-DEPTH SURVEY REPORT

A LABORATORY COMPARISON OF CONVENTIONAL DRYWALL SANDING TECHNIQUES VERSUS COMMERCIALLY AVAILABLE CONTROLS

AT

The Seattle-Area Apprenticeship Training Facility
The International Brotherhood Of Painters and Allied Trades
Seattle, Washington

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SURVEY DATE	April 25-29, 1994
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DISCLAIMER

Mention of company names or products does not constitute endorsement by the Centers for Disease Control and Prevention (CDC)

EXECUTIVE SUMMARY

An experimental evaluation was conducted at the Seattle-Area Apprenticeship Training Facility of the International Brotherhood of Painters and Allied Trades The experiment was designed to (1) Compare the performance of five off-the-shelf controlled sanding methods with conventional dry sanding techniques, and (2) Compare the relative exposures from conventional pole sanding and conventional hand sanding techniques The five controlled sanding methods included three pole-sanding controls and two hand-sanding controls These were subsequently compared with conventional pole and hand-sanding methods Six identical 8'x8'x8' rooms with drywall interiors were constructed Exposure comparisons were logged during sanding using a light-scattering particle detector mounted near the worker's breathing zone Each test run was also videotaped to employ video exposure monitoring techniques for further analysis A total of 43 test runs (36 regular and 7 modified) were conducted within the 6 booths All of the sanding during the test runs were performed by a single worker to eliminate inter-worker variability Each regular test run lasted approximately 20 minutes Test runs were blocked into groups of six A maximum of two blocks (12 runs) were performed per day Additional drywall mud was professionally applied by a single worker and allowed to dry after each block run The comparisons were made using an incomplete randomized block experimental design Experimental data reveal that all the engineering control designs were successful in reducing mean exposures to airborne particulate by 80 to 97 percent Four of the five controls reduced mean exposures by nearly 95 percent or more compared to their respective noncontrolled sanding technique Additionally, conventional pole sanding exposures averaged almost 45 percent less than conventional hand sanding exposures however wide confidence limits eliminated the statistical significance of this last finding

Subjective comments regarding worker acceptance of the tool designs were also collected Subjective comments revealed that some tools lacked sanding head flexibility and/or stability and some of the tools were perceived to be over-priced An additional control device was identified at the site but we were unable to incorporate it into the experimental design A single test run on this tool suggested that it also performs very well and tended to overcome most of the head-flexibility problems however the level of specificity is greatly reduced with only a single test run Based on the controls which were part of the experimental design, it is concluded that engineering controls are commercially available which can dramatically reduce worker exposures to drywall sanding dusts However, worker acceptance and implementation of these controls may require improved tool design and lowered equipment costs

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), a Federal agency located in the Centers for Disease Control and Prevention under the Department of Health and Human Services, was established by the Occupational Safety and Health Act of 1970 This legislation mandated NIOSH to conduct research and educational programs separate from the standard setting and enforcement functions conducted by the Occupational Safety and Health Administration (OSHA) in the Department of Labor. An important area of NIOSH research deals with methods for controlling occupational exposure to potential chemical and physical hazards

The Engineering Control Technology Branch (ECTB) of the Division of Physical Sciences and Engineering (DPSE), has been given the lead within NIOSH to study and develop engineering controls and assess their impact on reducing occupational illness Since 1976, ECTB has conducted a large number of studies to evaluate engineering control technology based upon industry, process, or control technique The objective of each of these studies has been to document and evaluate control techniques and to determine their effectiveness in reducing potential health hazards in an industry or at specific processes.

This study of drywall sanding techniques is the result of ECTB's contributions to the working partnership between NIOSH researchers and the Center to Protect Workers' Rights (CPWR) The CPWR is the research arm of the Building and Construction Trades Department (BCTD), American Federation of Labor and Congress of Industrial Organizations (AFL-CIO) The BCTD comprises 15 affiliate unions and 4 million members Recently, a NIOSH funded CPWR project monitored the construction of a new building from start to finish and documented as many occupational exposures as could be identified. In July 1993, the CPWR released the results of this study at the *National Conference on Ergonomics, Safety, and Health in Construction* [1] These study results highlighted exposures to noise, ergonomic hazards, chemical hazards, and airborne particulate The study indicated the high potential for both primary-worker and bystander hazardous exposures due largely to the absence of engineering controls Consequently, CPWR and NIOSH coordinated an engineering controls working group to look at the development and implementation of new and existing controls designed to reduce occupational exposures in the construction industry. One of the first focus areas of the ECWG was a request from the International Brotherhood of Painters and Allied Trades (IBPAT) to investigate implementation feasibility of engineering controls into the drywall finishing industry The experimental evaluation detailed in this report is part of the NIOSH response to this request

This research study reports the results of a comparative experimental evaluation of controlled and noncontrolled drywall sanding techniques The experimental evaluation was performed at the IBPAT's Apprenticeship Training Facility in Seattle, Washington In addition to supplying the facility, IBPAT representatives constructed the testing booths and provided the drywall workers for the study The primary purpose of the investigation was to evaluate identified commercially-available sanding controls and compare their exposure potential with traditional noncontrolled drywall sanding methods

FACILITY AND PROCESS DESCRIPTION

FACILITY DESCRIPTION

The IBPAT conducts training programs for apprentice painters and drywall finishers from the greater Seattle area at the Seattle-Area Apprenticeship Training Facility located on the campus of the South Seattle Community College This training is in conjunction with on-the-job-training the apprentice receives during their normal workday The apprenticeship training is primarily conducted during evenings and weekends The level of advancement through the apprenticeship program determines the pay scale of the employee. The Seattle facility is a large building consisting of offices, conference rooms, classrooms, and two adjacent high-bay areas The experiment was conducted in the larger of the two bay areas which measures approximately 35' wide x 50' long by 16' high Six identical wood framed structures measuring approximately 8'x8'x8' were constructed for this experiment The booths were evenly spaced along the two long perimeter walls of the bay area, three booths on each side, and sheetrock was applied to the ceiling and interior walls of each booth The interior surfaces of each booth were finished with joint tape and drywall compound and the booths were subsequently labeled A through F A schematic drawing of the high-bay configuration and a photograph showing one of the bay walls are pictured in Figures 1(a) and 1(b)

PROCESS DESCRIPTION

One employee from the apprenticeship training facility performed all of the sanding For each test run, the worker sanded the selected booth interior using a sanding tool randomly (within pole or hand category) pre-selected by the experimental protocol Regardless of the sanding tool selected, each tool used a 120 grit drywall sanding screen as its abrasive surface The worker began sanding for each test run at the leading edge of one wall and worked his way around the wall and the ceiling surfaces in such a manner as to complete the sanding task within approximately 20 minutes The worker was verbally advised of 5 minute intervals to facilitate the timing of his progression The worker performed this 20 minute sanding process six times per half-day experimental block When two blocks were scheduled for the same day, a second worker, the drywall finisher, began "remudding" a test booth immediately after it was sanded Heaters and fans helped to expedite the drying process The same drywall compound, Beadix Mud-lite Topping Compound, was used throughout the experiment and only one drywall finisher applied the fresh drywall compound for any particular test block The experimental sampling began on a Monday afternoon and continued through Thursday afternoon A total of 36 test runs of 20 minute duration were performed using the defined experimental protocol An additional test run was conducted using a drywall sanding control identified by the apprenticeship training facility employees and

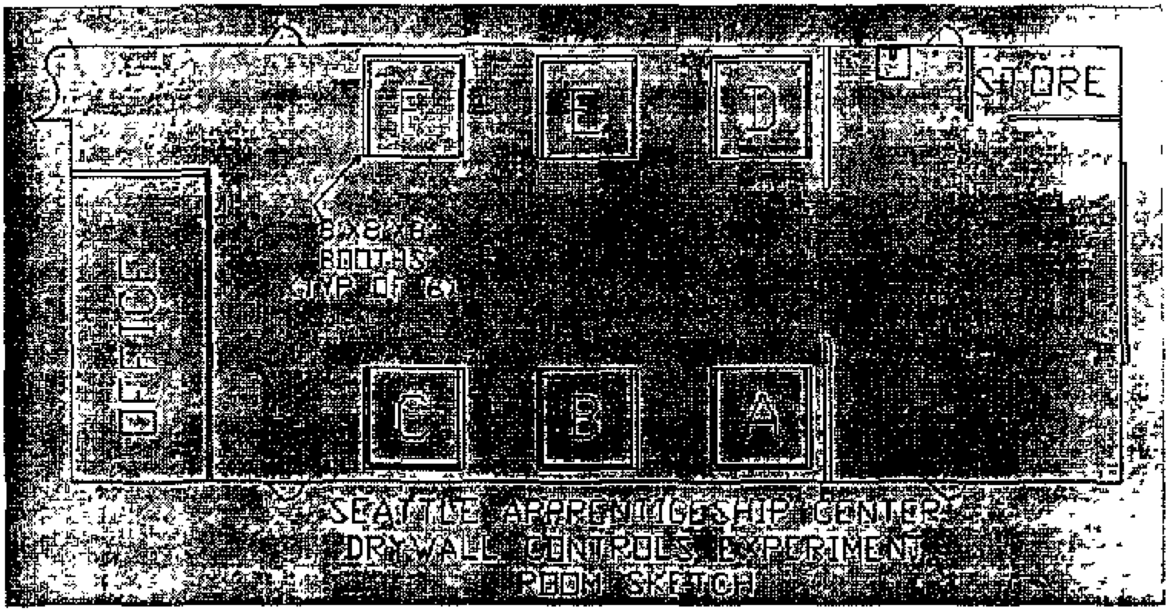

Figure 1a Schematic Drawing of Seattle Apprenticeship Training Center High-Bay Area as Configured for the Drywall Controls Experiment

Figure 1b Photograph of 3 Test Booths Distributed Along One Wall within the Training Center's High-Bay Area (Plastic Sheeting was used with Portable Heaters to Accelerate Compound Drying Times)

procurable through the local Seattle-area market On the last afternoon of the evaluation, a modified test block using 5 minute sampling runs in each booth was conducted to provide additional data in the remaining time allotted

HAZARDS AND EVALUATION CRITERIA

POTENTIAL HAZARDS

Presently, the primary concern with drywall finishing is the sanding process and its resulting airborne particulate generation Since the removal of asbestos from drywall compound, this seldom quantified exposure to drywall sanding dust has been regulated as "nuisance dust" or "particulate not otherwise classified (PNOC)" and thus, has not received the attention which perhaps it deserves This may be an unfortunate oversight since the drywall sanding process is a well-known dust generator and studies have shown that dust overloading can produce " significant and progressive retardation of macrophage-mediated dust removal "[2]

Depending on the brand and type of drywall compound used, airborne silica exposure may be a concern A review of material safety data sheets (MSDS)(See appendix A) from several different drywall compounds shows crystalline silica (quartz) contents ranging from "not listed" up to 2 5 percent weight/weight (Wt/Wt)[3-10] Recent analysis of both bulk (dry) and dust samples collected by CPWR and NIOSH researchers revealed total silica (quartz) concentrations up to 6 percent Wt/Wt in a brand of drywall compound which does not even list quartz silica as an ingredient Actual quartz content percentages may be further clouded if they are reported as a percentage of the premixed wet compound as opposed to a percentage of the dry compound The NIOSH bulk samples were collected from the dried compound Analytical results from the NIOSH samples are in Appendix B Crystalline silica is considered a health hazard by inhalation The International Agency for Research on Cancer (IARC) classifies crystalline silica as a probable carcinogen for humans (2A) Crystalline silica is also a known cause of silicosis, a noncancerous lung disease

Another drywall compound component which may warrant concern is nonfibrous talc Although not a listed component in all brands of drywall compound, talc is mentioned in some MSDS's as a hazardous ingredient Talc was recently the focus of a National Toxicology Program Report titled "Toxicology and Carcinogenesis Studies of Talc."[11] According to this report, there was a concentration-related impairment of respiratory function which increased in severity with increasing exposure duration in exposed male and female rats Additionally, the report concluded there was some evidence of carcinogenic activity of talc in exposed male rats and there was clear evidence of carcinogenic activity of talc in exposed female rats

EVALUATION CRITERIA

Since the focus of this survey was an experimental evaluation of engineering controls, the evaluated activities (sanding within the booth environment) were designed and conducted solely for the convenience of the scientific experiment and they were not intended to represent a worker's occupational exposure The steady work rate, smaller work confines of the booth, and an increased proportion of surface area requiring sanding intuitively indicate that exposures measured during these 20 minute sanding periods are not necessarily representative of "typical" occupational exposures For comparison purposes from one sanding technique to another, the work activities evaluated represented sanding activities which are commonly found in conventional work environments

The goal of the experiment was to compare the identified sanding controls against the appropriate noncontrolled conventional technique Controls for pole sanding were compared against conventional pole sanding and controls for hand sanding were compared against conventional hand sanding In addition, the blocks designed to evaluate hand sanding controls also included conventional pole sanding so that a comparison between conventional pole sanding and conventional hand sanding could be evaluated

METHODOLOGY

EXPERIMENTAL DESIGN

The experimental evaluation was conducted at IBPAT's Seattle-Area Apprenticeship Training Facility The experimental goals were (1) To compare the performance of five off-the-shelf controlled sanding methods with conventional dry sanding techniques, and (2) To compare the relative exposures from conventional pole sanding and conventional hand sanding techniques The sanding controls were identified and commercially acquired through advertisements in trade magazines, conversations with trade representatives, and walk-throughs at local (Cincinnati, OH) building supply stores The five controlled sanding methods included three pole-sanding controls and two hand-sanding controls These were subsequently compared with conventional pole and hand-sanding methods, respectively A summary list of the evaluated controls are listed in Table 1 Appendix C contains a more complete description of the evaluated controls and potential sources for their acquisition

For the experimental comparison, six "identical" 8'x8'x8' test booths with drywall interiors were constructed Exposure comparisons were logged during sanding using a light-scattering particle detector mounted near the worker's breathing zone Each test run was also videotaped to employ video exposure monitoring techniques for further analysis Forty-three test runs were conducted within the six booths All of the sanding during the test runs was performed by a single worker to eliminate inter-worker variability Each regular test run lasted approximately 20 minutes Test runs were blocked into groups of six A maximum of

Table 1 List of five sanding control configurations which were evaluated against conventional sanding techniques in the Seattle study

POLE SANDING CONTROLS	HAND SANDING CONTROLS
Sand & Kleen (Pole)	Sand & Kleen Hand Sander
Sand Duster Kit with Commercial Vacuum	FibaTape Hand Sander
Sand Duster with Quiet Vacuum System	

two blocks (12 runs) were performed per day Additional drywall mud was professionally applied and allowed to dry after each block run Portable heaters, fans, and plastic enclosures were all used to minimize the drying times required between block runs The same drywall compound, Beadix Mud-lite Topping Compound, was used throughout the experiment and only one drywall finisher was used to apply fresh drywall compound during any particular test block The test run and blocking sequences were pre-selected using an incomplete randomized block experimental design

INDUSTRIAL HYGIENE SAMPLING

Initially, both direct reading particle counters and a modified industrial hygiene gravimetric method were selected to monitor the exposures generated from each of the test runs The modified sampling train included a pre-weighed 37 millimeter filter cassette tethered to a high-volume cylindrical pump through a critical flow orifice calibrated at 12 24 liters per minute (L/min) Due to the significant dust produced by the sanding process during the 20 minute test runs, the excessive pressure drop across the filter cassette shifted the orifice out of its critical operating range and a consistent pump flow rate was unobtainable This resulted in an increased reliance upon the real-time exposure results for exposure comparisons between test runs

Video Exposure Monitoring (VEM), an exposure evaluation technique developed by ECTB[12], was used to evaluate each of the test runs In VEM, the analog output of a direct-reading instrument, in this case the Hand-held Aerosol Monitor (HAM, PPM Inc , Knoxville, TN), is recorded electronically with a data logger (Rustrak® Ranger, Gulton, Inc , East Greenwich, RI) Using a shoulder harness, the HAM was positioned high on the worker's chest near the breathing zone A battery-operated personal sampling pump (calibrated at 2 L/min) pulled air through the HAM's sensing chamber In the HAM, light from a light-emitting diode is scattered by the aerosol, and forward scattered light is detected by a receiver Figures 2 (a) & (b) show views of the drywall sander wearing the HAM and associated equipment Figure 3 shows the equipment required for on-site mixing of the VEM signals The analog output of the HAM is proportional to the amount of forward scattered light However, the calibration of the HAM varies with aerosol properties such as the

Figures 2 (a) and (b) show the aerosol monitor, pump, and data-logger mounted on the drywall sander while sanding and during pump calibration

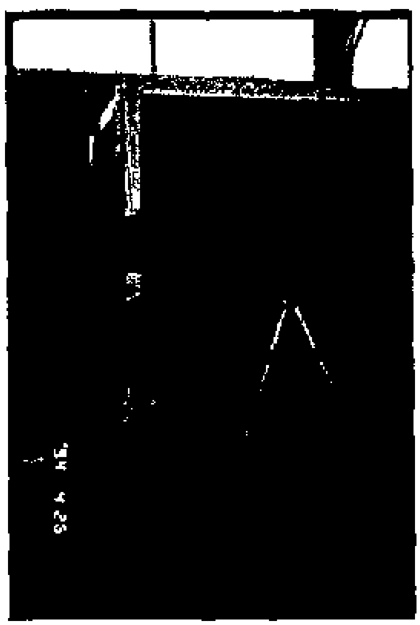

Figure 3 (left) shows the video camera, portable computer, and monitoring equipment required for on-site mixing of the VEM signals refractive index and particle size of the analyte Therefore, the analog output of the HAM will be expressed as relative concentrations which have no units

While relative air contaminant concentrations were logged, the sanding activities were recorded on videotape The analog output of the direct-reading instrument was overlaid onto the video recording as a moving bar which has a height proportional to the air contaminant concentration This technique reveals on the video monitor how worker exposures are related to work activities and permits recommendations which are focussed upon actual exposure sources In addition to the research benefits of this method, these video recordings will be used by IBPAT and similar organizations to train workers to avoid certain work practices which elevate exposures as well as to demonstrate the benefits of proper controls

The researchers were concerned that dust generated from a previous test run would still be present in the bay area and possibly affect the results of subsequent test runs As a guard against this, a second HAM was used in the general bay area between test runs to compare general area readings in the bay against those found outside in the ambient environment Subsequent test runs were not initialized until general area bay readings were within the range of those found in the outside environment To verify the accuracy of this approach, the experimental protocol was designed so that sequencing effects could be evaluated in the statistical analysis of the test runs Results of the sequence effect analysis determined no apparent influencing effect upon the data results as a result of a test run's sequence

VENTILATION

General ventilation was present in the high bay and adjacent areas and was operating in a recirculating heating mode during the week of the survey During the 20 minute test runs, this system was deactivated to protect against any potential influences which air disturbances from this system could have on the test results Between test runs, the system was re-activated if air tempering was desired and the side-entry doors into the bay and a large overhead door were opened to quickly dissipate any dust generated from the previous test run

RESULTS

REAL TIME MONITORING

Video recording and real-time monitoring were performed during each of the test runs All the tests were performed within the four day survey period This resulted in approximately 1200 data points per 20 minute run (1 data point per second) Thirty-six regular test runs (6 blocks at 6 runs per block) of approximate 20 minutes of length were evaluated An additional test block using run durations of approximately 5 minutes each and a single test run on the locally procured control were also performed

The Rustrak data logger receives the HAM's analog output signal once every 650 milliseconds (ms) Next, the logger uses a one second averaging period to record the values Each one second interval recorded is reported in four ways, the highest value received during the interval, the lowest value, the average value, and the value at the end of the one second interval For this project, the average value for each interval was the data point used for both the data analysis and the video exposure monitoring Appendix D contains a summary of data from each of the test runs as well as graphs depicting the mean voltage value for each test run displayed according to the test block in which the run occurred

A list of the sanding configurations included under the pole and hand-sanding categories are shown in Table 2

Table 2 List of sanding configurations

Pole-Sanding Category	Hand-Sanding Category
Sand and Clean (Pole)	Sand and Clean Hand Sander
Sand Duster Kit w/Commercial Vacuum	FibaTape Hand Sander
Sand Duster with Quiet Vac System	Conventional hand-sanding
Conventional pole-sanding	Conventional pole-sanding

Mean exposures were calculated for each individual run by totaling the voltages recorded during the test run and dividing by the number of seconds sampled to get a mean voltage value for the individual test run These values were then grouped according to the type of sanding control and a mean-of-means was calculated for each of these groups Figures 4 (a) and (b) compare the mean-of-means exposures from each sanding control against the conventional sanding method for the respective category

FIGURE 4 An arithmetic mean-of-means comparison of controlled vs noncontrolled sanding methods for each sanding category In Figure 4(a), all of the controls were very effective in reducing the sander's mean personal exposure during sanding In Figure 4(b), both of the hand controls reduced the sander's mean personal exposure by over 95 percent Additionally, the graph indicates that simply switching from hand sanding techniques to pole sanding techniques reduced the arithmetic mean personal exposures by approximately 45 percent The importance of this 45 percent reduction was greatly diminished after a small sample size and subsequently wide confidence interval determined this reduction was not statistically significant

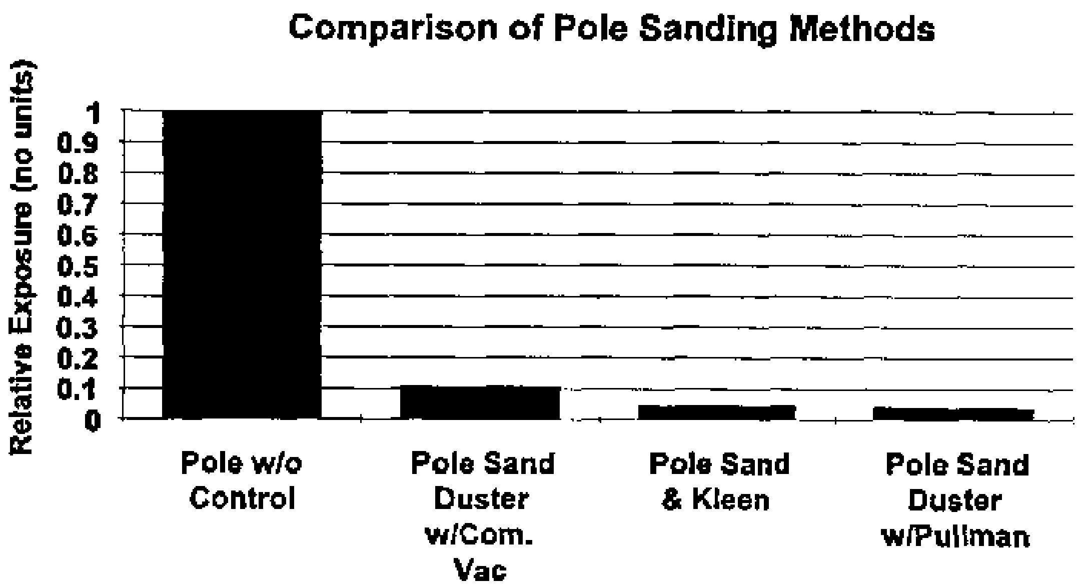

Figure 4(a) Comparison of Pole Sanding Methods.

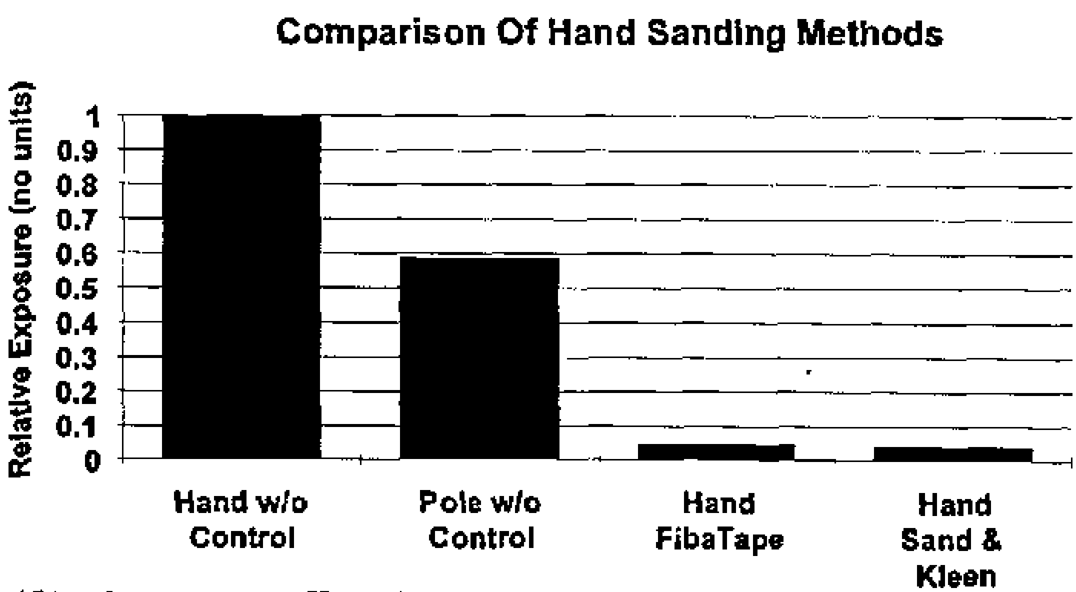

Figure 4(b) Comparison of Hand Sanding Methods

A detailed statistical analysis of the real-time data individually evaluated results from the pole-sanding and hand-sanding test blocks Both of these reports are located in Appendix E

Gravimetric Sampling

Due to difficulties in maintaining a consistent high-volume pump flow, we were unable to establish a numerical relationship between values recorded by the Hand Held Aerosol Monitor and the modified gravimetric industrial hygiene sampling methods The modified sampling train included a pre-weighed 37 millimeter filter cassette tethered to a high-volume cylindrical pump through a critical flow orifice calibrated at 12.24 liters per minute (L/min) The purpose for originally conducting the gravimetric sampling was to potentially establish a relationship between the modified gravimetric dust exposure results and the numerical data recorded by the HAM Had this relationship been established, it could have provided more insight into interpreting the relative exposures recorded by the HAM. Although the data confirms the expected trend of increasing total dust concentrations measured during test runs with increasing mean voltage responses from the aerosol monitor, the flow problems and subsequently limited data set prevent determination of an accurate mathematical relationship between the two data sets for this experiment

SUBJECTIVE COMMENTS AND OBSERVATIONS

At the conclusion of the final test block, the drywall sander provided subjective comments for each of the sanding controls evaluated during the experiment as well the Dustless Drywall Machine (DDM) which is the drywall sanding control procured in Seattle There were two Sand Duster controls evaluated during the experiment, however, the only difference between the two was the vacuum system For this reason, the subjective comments regarding the sanding poles' performance were the same for each tool Table 3 summarizes the sander's subjective comments as well as some researcher observational comments for each of the sanding controls

CONCLUSIONS AND RECOMMENDATIONS

The results of this experiment clearly show that dust generation from drywall sanding can be substantially reduced through the use of engineering controls Despite the lack of published exposure data, drywall sanding is well known within the construction industry to be an extremely dusty operation A review of drywall compound MSDSs' reveals numerous acknowledgments of potentially hazardous ingredients, recommendations to avoid dry sanding and to use wet sanding methods, recommendations for local ventilation, and recommendations for respiratory protection This indicates that drywall compound manufacturers already recognize the potential hazards associated with exposures to excessive levels of drywall sanding dust In actual work practice however, very few of these recommendations are followed Wet sanding is not used due to time and finish-texture requirements Engineering controls are primarily used only when it is necessary to protect the environment (for example, a computer room) as opposed to protecting the worker If respiratory protection is used, it is often used incorrectly with little concern or training given to proper selection or fit

Individuals opposing the use of engineering controls in drywall sanding will cite reduced productivity as the primary deterrent to control implementation While this may be true initially, as familiarity progresses, the difference in productivity rates should diminish In addition, there should be less time spent cleaning-up after drywall sanding, significantly reduced airborne dust exposures to primary and adjacent workers, less re-work required due to dust affecting adjacent painting (or other finishing) operations, and fewer carpet cleaning bills due to drywall dust being tracked all over the construction site In addition to the improved cleanliness, drywall sanders who use engineering controls will be less likely to require respiratory protection, they will be substantially less irritated by falling drywall dusts and thus should be more comfortable, more alert to their surroundings, and probably more productive

This study explicitly indicates that the evaluated drywall sanding controls were effective in reducing worker exposures to dust generated from drywall sanding Some of the controls appeared to be limited in design and could provide broadened applicability with only minimal design modifications However, these limitations do not totally restrict the use of these controls under most current working conditions There is some evidence to indicate that avoiding hand-sanding operations, especially when working overhead, can also reduce a worker's personal exposure This issue and other questions raised by this experimental evaluation will be the focus of future research into this work activity

Table 3 Sander's subjective comments and researcher's observational comments

CONTROL	SUBJECTIVE COMMENTS	OBSERVATIONS
Pole Controls		
Sand Duster w/Pullman Quiet Vacuum System	(1) Difficult to use on upper areas of wall due to poor flexibility in sanding head (2) Heavy hose.	(1) Good dust collection (2) Poor posture required to sand higher wall levels due to head flex problems (3) Low Vacuum noise
Sand Duster w/Commercial Vacuum System	Same as above	Same as (1) & (2) above
Sand & Kleen (w/water filtration bucket)	(1) Better sanding head movement (2) Sanding head tends to flip and gouge drywall (3) Maintenance of water bucket could be a problem at actual job site (4) Nice light hose	(1) Good dust collection (2) Changing water in bucket is a nuisance (3) Hose between water bucket and vacuum is difficult to clean
DDM (locally procured)	(1) Moderate head flex problems (2) Moderate tendency for sanding head to flip however less surface gouging occurs (3) Heavy hose	(1) Good dust collection (2) Some flexibility and flipping problems noted
Hand Controls		
Sand Duster	(1) Uncomfortable handle design (2) Light, easy to maneuver (3) Excessive distance separating handle and sanding surface (4) Light hose	(1) Good dust collection (2) Changing water in bucket is a nuisance (3) Hose between water bucket and vacuum is difficult to clean
FibaTape	(1) Comfortable handle (2) Hose and attachment are heavy and cumbersome	(1) Good dust collection (2) Poor hose connection (3) Good handle design

REFERENCES

1 CPWR [1993] Final Report An Investigation of Health Hazards on a New Construction Project Washington, D C The Center To Protect Workers' Rights

2 Morrow H, Muhle H, Mermelstein R [1991] Chronic inhalation study findings as a basis for proposing a new occupational dust exposure limit J Am Coll Toxicol *10*(2) 279-290

3 National Gypsum Company [1993] Material safety data sheet (MSDS) No 05002 Charlotte, NC

4 U S Gypsum Company [1993] MSDS Joint treatment products-ready mixed compounds Chicago, IL

5. Holdings GH [1991] MSDS Creative drywall compound Mississauga Ontario, Canada

6 Synkoloid Company Of Canada [1990] MSDS Synco powdered drywall joint cements Surrey British Columbia, Canada

7 Synkoloid Company Of Canada [1990] MSDS. Synco premixed drywall joint cements and textures Surrey British Columbia, Canada

8 Georgia Pacific Corporation [1992] MSDS Ready Mix Joint/Topping Compounds Atlanta, GA

9 Kadex Corporation of Indiana [1985] MSDS Ready to use drywall compounds (liquids & powders) Fort Wayne, IN

10 Beadex Manufacturing Company [1992] MSDS Beadex Multi-purpose, Taping, and Topping compounds Auburn, WA

11 NTP No 421 [1993] NTP results report, Toxicology and carcinogenesis studies of talc in F344/N rats and $B6C3F_1$ mice (inhalation studies) [Abstract] National Institutes of Health, Public Health Service, U S Department of Health and Human Services

12 NIOSH [1992] Analyzing Workplace Exposures Using Direct Reading Instruments and Video Exposure Monitoring Techniques Cincinnati, OH U.S Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No 92-104

13 USG [1992] Gypsum Construction Handbook Chicago, IL: United States Gypsum Company

APPENDICES

APPENDIX A MATERIAL SAFETY DATA SHEETS

This appendix contains the material safety data sheets (MSDS) from drywall compound manufacturers known to the researcher at the time of this study They are believed to represent the majority of manufacturers who produce drywall compound within the United States and Canada however this is not to be interpreted as an all-inclusive list The information provided is believed to be the most recent MSDS versions available at the time of this research evaluation Individuals requiring up-to-date information are advised to obtain updated revisions directly from the manufacturers

MATERIAL SAFETY DATA SHEET

REVISED
OCTOBER 1992
PREPARATION DATE MARCH 1989

SECTION 1 – PRODUCT IDENTIFICATION

Manufactured by Beadex Manufacturing Company, Inc
401 C Street N W
Auburn, WA 98001-3908

Information / Emergency Phone Numbers (206) 931-6600

Chemical Name Mixture of Chemicals

Common Name Beadex Mud Lite Multi Purpose Compound, Beadex Mud-Lite Taping Compound, Beadex Mud Lite Topping Compound, Beadex Gold Multi Purpose Compound, Beadex Premium All Purpose Compound, Beadex Premium Taping Compound, Beadex Premium Topping Compound, Beadex Pre-Thinned Taping Compound, Beadex Tape-N Tex

SECTION II – HAZARDOUS INGREDIENTS

CHEMICAL & COMMON NAME	CAS NO	APPLICABLE EXPOSURE LIMITS	
		OSHA-PEL	ACGIH-TLV
TALC	14807-96-6	not available	2 mg /cu m**
MICA	12001-26-2	20MPPCF*	3 mg /cu m*
CLAYS (MAGNESIUM ALUMINUM SILICATES)	8031-18-3	15 mg /cu m*	10 mg /cu m*
CALCIUM CARBONATE	1317-65-3	5 mg /cu m**	10 mg /cu m*
SILICA (QUARTS)***	14808-60-7	30mg /(%50 +3)*	10mg /(%50 +2)**
PERLITE	93763-70-3	—	10mg /cu m*

* total dust ** respirable dust *** present as a natural occurring contaminant

SECTION III – PHYSICAL / CHEMICAL CHARACTERISTICS

BOILING POINT Approx 212°F
VAPOR PRESSURE (mm Hg) That of water approx
VAPOR DENSITY (AIR = 1) Not Known
SOLUBILITY IN WATER Dispersible in water
APPEARANCE & ODOR Low odor, off white paste
SPECIFIC GRAVITY (H_2O = 1) 1 1 – 1 9
MELTING POINT N/A
pH 7 0 – 10 0

SECTION IV – FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method Used) N/A
EXTINGUISHING MEDIA N/A
FLAMMABLE LIMITS N/A
SPECIAL FIRE FIGHTING PROCEDURES None, not combustible
UNUSUAL FIRE AND EXPLOSION HAZARDS None

SECTION V – REACTIVITY DATA

STABILITY Stable
CONDITIONS TO AVOID Contact with strong mineral acids
INCOMPATIBILITY (Materials to avoid) Strong mineral acids
HAZARDOUS POLYMERIZATION will NOT occur

SECTION VI – HEALTH HAZARD DATA

ROUTE(S) OF ENTRY Inhalation – Yes Skin – No Ingestion – Yes

HEALTH HAZARDS (Acute and Chronic) Skin and/or eye contact may cause mild irritation if prolonged exposure Repeated inhalation of respirable dust in excess of the TLV may cause chronic respiratory disorders

CARCINOGENICITY NIP – No IARC Monographs – No OSHA Regulated – No

MEDICAL CONDITIONS (Generally aggravated by exposure) Asthma or similar breathing disorders

EMERGENCY AND FIRST AID PROCEDURES

- INGESTION May result in obstruction, if ingested see physician This material is not known to be toxic
- INHALATION Move to area with fresh air
- EYE CONTACT Remove contact lenses, rinse eyes with plenty of water for 5–10 min If irritation or mechanical injury occurs, contact physician
- SKIN CONTACT Prolonged exposure may cause mild irritation

SECTION VII – PRECAUTIONS FOR SAFE HANDLING AND USE

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED Shovel spilled material into waste container for reuse or disposal Clean up with water

WASTE DISPOSAL METHOD As per local regulations

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING Do not freeze, store in dry area where ambient temperature can be maintained between 36° and 86° Do not ingest Keep out of reach of small children Avoid contact with strong mineral acids Avoid contact with skin when possible

SECTION VIII – CONTROL MEASURES

RESPIRATORY PROTECTION (Specify Type) Use of NIOSH approved dust mask recommended when sanding
LOCAL EXHAUST As appropriate to minimize dust conditions
PROTECTIVE GLOVES May be desirable to protect against drying of hands
EYE PROTECTION Close fitting goggles as appropriate for nuisance dust
WORK HYGENIC PRACTICES When mixing or sanding minimize dust and use wet sponging in lieu of dry sanding whenever possible

MATERIAL SAFETY DATA SHEET

United States Gypsum Company
125 South Franklin Street
Chicago, IL 60606-4678

Emergency No (312) 606-4542
Date Issued. April 20, 1993

SECTION I

PRODUCT GROUP: Joint Treatment Products - Ready Mixed Compounds

USG® Plus III Total Joint Compound
DURABOND® Wallboard Compound
USG® - All Purpose
COVER COAT® Compound
SHEETROCK® All Purpose Joint Compound
DURABOND® Light 'n Easy Joint Compound
SHEETROCK® Lightweight All Purpose Joint Compound
USG® Lightweight All Purpose Joint Compount (K-LITE)
SHEETROCK® Lightweight All Purpose - Regal
SHEETROCK® Topping Joint Compound
USG® - Topping I
USG® - Topping II
USG® - Topping III
USG® - Taping
SHEETROCK® Taping Joint Compound

® - Trademark of United States Gypsum Company or an affiliated company

CHEMICAL FAMILY Mixture

SECTION II
INGREDIENTS

MATERIAL	%	TLV mg/M³	PEL mg/M³	CAS No
Limestone*		10	15/5(R)	1317-65-3
Water		(NE)	(NE)	7732-18-5
Mica		3(R)	20MPPCF	12001-26-2
Talc (Non-Fibrous)		2(R)	20MPPCF	14807-96-6
Expanded Perlite		10	15/5(R)	93763-70-3
Attapulgite		10	15	12174-11-7
Vinyl Acetate Polymer		(NE)	(NE)	9003-20-7
Ethylene Glycol	0 1	127(C)	125(C)	107-21-1
*Alternate Material				
Gypsum		10	15/5(R)	13397-24-5

(C)-Ceiling (R)- Respirable (NE)-Not Established

***** This is a Non-Asbestos Product *****

SECTION III
PHYSICAL DATA

SPECIFIC GRAVITY (H_2O = 1) 1 6
pH = 8 to 9 5
PERCENT VOLATILE BY VOLUME Approximately 35%
VOC = less than 20 grams per liter
VOS = less than 0 17 pounds/gallon
APPEARANCE AND ODOR: Off white paste, low odor

SECTION IV
FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (METHOD USED) None
EXTINGUISHING MEDIA- Not Combustible
SPECIAL FIRE FIGHTING PROCEDURES None
UNUSUAL FIRE AND EXPLOSION HAZARDS· None

SECTION V
HEALTH HAZARD DATA

EFFECTS OF OVEREXPOSURE:

ACUTE

EYES. Spray mist or dust from dry sanding may cause transitory irritation
SKIN May dry skin
INHALATION Breathing of spraying mist or dust from dry sanding may cause irritation to the eyes, nose, throat or upper respiratory system
INGESTION None known

CHRONIC

EYES None known
SKIN None known
INHALATION. Long term inhalation of large amounts of respirable mica or talc dust can cause lung damage (pulmonary fibrosis)
INGESTION None known

EMERGENCY AND FIRST AID PROCEDURES.

EYES Flush thoroughly with water for 15 minutes to remove particles
If irritation continues, consult physician
SKIN Wash with soap and water
INHALATION Remove to fresh air
INGESTION Call physician

TARGET ORGANS Lungs
MEDICAL CONDITIONS WHICH MAY BE AGGRAVATED. Pre-existing upper respiratory and lung disease such as, but not limited to, bronchitis, emphysema and asthma
PRIMARY ROUTE OF ENTRY Inhalation.

CARCINOGENICITY OF INGREDIENTS

Material	IARC	NTP	OSHA
All	Not listed	Not listed	Not listed

SECTION VI
REACTIVITY DATA

STABILITY: Stable
HAZARDOUS POLYMERIZATION Will not occur

A3

SECTION VII
SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Scoop up. Wash down area before material dries

WASTE DISPOSAL METHOD: Deposit in sanitary landfill in accordance with federal, state and local regulations

SECTION VIII
SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION	If dry sanded, wear a NIOSH-approved dust respirator
VENTILATION	General mechanical or local exhaust
PROTECTIVE EQUIPMENT	Safety glasses or goggles.

SECTION IX
SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: When finishing joints using these products, wet-sanding is recommended See "Finishing and Decorating Gypsum Panels - Wet Sanding, J-610/12-87". Store in a cool, dry place. Avoid freezing

⚠ WARNING

When applying or sanding, wear safety glasses or goggles If eye contact occurs, flush thoroughly with water for 15 minutes to remove particles If irritation continues, consult physician. Use wet-sanding technique to avoid creating dust If dry sanding, wear a NIOSH-approved dust mask Dust created from dry sanding may cause eye, nose, throat or upper respiratory irritation Long-term breathing of large amounts of mica or talc may cause lung disease Do not take internally. If child ingests, stay calm, material is nontoxic If there is any discomfort, consult physician Emergency product safety information: (312) 606-4542

KEEP OUT OF REACH OF CHILDREN.

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A4

MATERIAL SAFETY DATA SHEET 05002

National Gypsum Company
2001 Rexford Road
Charlotte, NC 28211

For emergency product safety information, call Mr. Thomas Welty, Director Quality Services Management at 704-365-7543

I PRODUCT IDENTIFICATION

This material safety data sheet is applicable to the following products:

Gold Bond All Purpose Ready Mix Joint Compound
Gold Bond Ready Mix Topping Compound
Gold Bond Level 5 Compound
Gold Bond Ready Mix Taping Compound
Gold Bond ProForm
Gold Bond Lite Ready Mix Joint Compound

Chemical Family Mixture

II HAZARDOUS INGREDIENTS

Contains Chemical Identity	CAS-NO	OSHA PEL (mg/m^3)	ACGIH TLV (mg/m^3)
Calcium Carbonate	1317-65-3	5	10*
Quartz **	14808-60-7	***	0 1

and may contain one or more of the following

Mica	12001-26-2	20 mppcf	3
Talc (non-asbestiform)	14807-96-6	20 mppcf	2
Perlite	93763-70-3	5	10*
Attapulgite Clay	12174-11-7	NL	NL

Contains no asbestos
NL - not listed
* Total dust. All others are respirable dust
** Present as a naturally occurring component of minerals See Sec III HEALTH HAZARD DATA.
*** Respirable dust. Use the formula $10\ mg/m^3 \div \%SiO_2 + 2$.

Appearance and Odor
A white paste with no odor.

Fire Hazard Data - Not combustible
Extinguishing Media
Dry chemical, foam, water fog or spray.

Special Firefighting Procedures
Wear full protective equipment and an approved pressure demand self-contained breathing apparatus

Reactivity Data
Gold Bond Ready Mix Products are stable and hazardous polymerization will not occur When heated to decomposition oxides of carbon will be released

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III HEALTH HAZARD DATA

Carcinogenicity

Substance	NTP	IARC	OSHA
Quartz (crystalline silica)	YES	2A	NO

Caution: Contains quartz (crystalline silica)

The International Agency for Research on Cancer (IARC) classes this substance in Group 2A, which IARC defines as "probably carcinogenic to humans". According to IARC there is sufficient evidence for the carcinogenicity of crystalline silica to experimental animals and limited evidence for the carcinogenicity of crystalline silica to humans On the basis of sufficient evidence of carcinogenicity in experimental animals NTP (National Toxicology Program) places this substance in the group "which may reasonably be anticipated to be carcinogens".It is recommended that a NIOSH approved respirator,for toxic dusts,be worn whenever working with this product results in airborne dust exposure exceeding the prescribed limits Quartz is not classified as a carcinogen by OSHA

Substance	NTP	IARC	OSHA
Attapulgite	NO	3	NO

Note IARC classes attapulgite clay in Group 3 which is used to describe substances whose carcinogenicity to humans because of inadequate evidence, cannot be classified as possible,probable, or definite

IARC reported inadequate epidemiological evidence for the carcinogenicity of attapulgite clay to humans noting that injection of attapulgite clay into experimental rats has been shown to induce tumors Attapulgite is not classified as a carcinogen by NTP or OSHA

Skin Contact
Continued and prolonged contact may cause transient irritation to the skin.

Eye Contact
Direct contact may cause eye irritation

Inhalation
Exposure occurs when sanding the dried product
Target Organ respiratory system.

Signs and Symptoms of Exposure to Airborne Dust
Continued and prolonged exposure to airborne dust concentrations in excess of the PEL/TLV may result in cough,dyspnea,wheezing and impaired pulmonary function

Medical Conditions Generally Aggravated By Exposure
Overexposure would generally aggravate respiratory system dysfunctions.

MATERIAL SAFETY DATA SHEET 05002

First Aid Procedures

Eye Immediately flush eyes with water for 15 minutes and get medical attention.

Skin: Flush and wash skin with soap and water Get medical attention if irritation persists.

Breathing: Move the exposed person to fresh air at once. If not breathing initiate pulmonary resuscitation. Get medical attention

IV PRECAUTIONS for SAFE HANDLING

Steps to be Taken in Case Material is Released or Spilled

Shovel or scoop up back into container for use if possible or disposal

Waste Disposal Method

Not a hazardous waste Dispose of in accordance with applicable federal,state and local regulations

Precautions to be Taken in Handling and Storing

Keep from freezing to preserve usefulness

V CONTROL MEASURES

Work/Hygiene Practices

Avoid creating dust

Ventilation

Provide ventilation to maintain a dust level below the PEL/TLV

Respiratory Protection

A NIOSH approved respirator for toxic dusts is recommended if the PEL/TLV is exceeded

Eye Protection

Safety glasses or goggles

Effective Date October 1,1993

Prepared by: Norbert W Kaleta

Disclaimer of Liability

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*                              M S D S                            *
*                                                                 *
*       Canadian Centre for Occupational Health and Safety        *
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*** IDENTIFICATION ***

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RECORD NUMBER                  : 314469
LANGUAGE                       . ENGLISH
PRODUCT NAME(S)                : 3120 - CREATIVE DRYWALL COMPOUND
PRODUCT IDENTIFICATION DATA    · Product Code  3120
DATE OF MSDS                   : 1991-05-01
```

*** MANUFACTURER INFORMATION ***

```
MANUFACTURER                   : G H HOLDINGS
ADDRESS                        : 2540 RENA ROAD
                                 MISSISSAUGA  ONTARIO
                                 CANADA    L4T 3C9
                                 Telephone   416-677-5522
EMERGENCY TELEPHONE NO (S)       613-996-6666  (CANUTE(C 24 hr)
```

*** SUPPLIER INFORMATION ***

```
SUPPLIER/DISTRIBUTOR             G H HOLDINGS
ADDRESS                          2540 RENA ROAD
                                 MISSISSAUGA  ONTARIO
                                 CANADA    L4T 3C9
                                 Telephone   416-677-5522
EMERGENCY TELEPHONE NO (S)     · 613-996-6666  (CANUTE(C 24 hr)
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*** MATERIAL SAFETY DATA ***

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            3120E      MATERIAL SAFETY DATA SHEET       PAGE 1
                       --------------------------
                                    ABBREVIATIONS   NA=NOT APPLICABLE
                                                    ND=NOT DETERMINED
                                                    NE=NOT ESTABLISHED

                                                    HEALTH=
                                                    FLAMMABILITY=
                                                    REACTIVITY=
                                                    PERSONAL PROTECTION= +
WHMIS CLASSIFICATION   D2                           + SEE SECTION VII
=========================================================================
                SECTION I  PRODUCT IDENTIFICATION AND USE
-------------------------------------------------------------------------
MATERIAL NAME/IDENTIFIER   3120 - CREATIVE DRYWALL COMPOUND

MANUFACTURER/SUPPLIER   G H  HOLDINGS
                        2540 RENA ROAD
                        MISSISSAUGA, ONTARIO L4T3C9
            PHONE   1-416-677-5522
        EMERGENCY   1-613-996-6666 CANUTEC(24 hr  emergency information only)

CHEMICAL FAMILY   Mixture
CHEMICAL FORMULA/MOLECULAR WT   N/A
TRADE NAME AND SYNONYMS   N/A
MATERIAL USE   Filling and finishing of drywall panel joints and fastener
               heads
P I N    N/A
=========================================================================
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SECTION II HAZARDOUS INGREDIENTS

CHEMICAL NAME	OSHA-PEL	ACGIH-TLV	LD50/LC50	%WT/WT
Silica Quartz (A component of Calcium Carbonate)	-	-	ND	1 5-2 5

CAS #14808-60-7

SECTION III PHYSICAL DATA

APPEARANCE, PHYSICAL STATE AND ODOR Thick paste, grey buff smooth paste
ODOR THRESHOLD (PPM) N/A
SPECIFIC GRAVITY/DENSITY (G/ML) 1.7-1 8
VAPOR PRESSURE (MM) N/A
VAPOR DENSITY (AIR=1) N/A
EVAPORATION RATE (BUAC=1) N/A
BOILING POINT 100 Deg C
MELTING/FREEZING POINT 0 Deg C.
PH 8
COEFFICIENT OF WATER/OIL DISTRIBUTION ND

SECTION IV FIRE OR EXPLOSION DATA

FLASH POINT N/A - Water based
AUTO IGNITION TEMPERATURE N/A
SENSITIVITY TO MECHANICAL IMPACT N/A
EXPLOSIVE POWER N/A
UPPER EXPLOSION LIMIT N/A
LOWER EXPLOSION LIMIT N/A
RATE OF BURNING N/A
SENSITIVITY TO STATIC DISCHARGE N/A
EXTINGUISHING MEDIA N/A

SPECIAL FIRE FIGHTING PROCEDURES
NA
UNUSUAL FIRE AND EXPLOSION HAZARDS
NA
FLAMMABILITY NO
UNDER WHAT CONDITIONS N/A

SECTION V REACTIVITY DATA

STABILITY - MATERIAL IS Stable

HAZARDOUS DECOMPOSITION/COMBUSTION PRODUCTS
Carbon dioxide, carbon monoxide
INCOMPATIBILITY (MATERIALS TO AVOID)
Acids and strong oxidizing agents
HAZARDOUS POLYMERIZATION
Will not occur

SECTION VI TOXICOLOGICAL PROPERTIES

PRIMARY ROUTES OF ENTRY
Inhalation - Skin - Ingestion - Eye
EFFECTS OF OVEREXPOSURE, CHRONIC
None known - Note When sanding risks of above and inhalation increase Protective measures should be used (See Section VII)
EFFECTS OF OVEREXPOSURE, ACUTE
Ingestion Can cause gastrointestinal upset Eyes May cause slight irritation Skin Prolonged/repeated contact may cause slight irritation to sensitive skin

CARCINOGENICITY None
LD50 OF PRODUCT ND LC50 OF PRODUCT ND
IRRITANT? As above SENSITIZER? A possible skin sensitizer
SYNERGISTIC MATERIALS None
REPRODUCTIVE EFFECTS None TERATOGENIC None MUTAGENIC None

SECTION VII PREVENTIVE MEASURES, SAFE HANDLING AND USE, REGULATORY INFORMATION

LEAK AND SPILL PROCEDURES
Contain spill, shovel or scoop into container Wash area with water Do not flush into drains. Dry area with absorbent
WASTE DISPOSAL METHOD
Dispose in accordance with local regulations
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE
Store in cool area, protect from freezing
VENTILATION
None needed when material is wet If sanding isolate working area and wet sweep or vacuum
RESPIRATORY PROTECTION
Only if sanding (nuisance dust)

PROTECTIVE GLOVES Use if sanding
EYE PROTECTION Use if sanding
OTHER PROTECTIVE EQUIPMENT NO
SPECIAL SHIPPING INFORMATION Not regulated

SECTION VIII FIRST AID MEASURES

EMERGENCY AND FIRST AID PROCEDURES
Eye Contact Flush eyes immediately with plenty of water If irritation persists, seek medical attention Skin Contact Wash area with mild soap and plenty of water If irritation persists, seek medical attention Ingestion Do not induce vomiting Drink plenty of water, or milk Seek medical attention

*Keep out of reach of children

SECTION IX PREPARATION INFORMATION

Prepared by Product Safety Division/ H Frances
Date May 1, 1991

The information accumulated herein is believed to be accurate but is not warranted to be, whether originating with the Company or not Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances

3120E

M S D S

Canadian Centre for Occupational Health and Safety

*** IDENTIFICATION ***

RECORD NUMBER . 281884
LANGUAGE ENGLISH
PRODUCT NAME(S) Synko Powdered Drywall Joint Cements and textures

A10

Synko Pure Velvet Synko Ruff-Tex Synko Joint Cement Synko Snow-Tex Synko Imperial Synko Stiro-Tex Synko Jet-Set Synko Super Ceiling Synko Fast Set Synko Wall-Tex Synko Lite-Ning Set Synko Ultra Span Synko Concrete Fill Synko Span Texture Synko Acrilite

DATE OF MSDS . 1990-07-01

*** MANUFACTURER INFORMATION ***

MANUFACTURER . The Synkoloid Company of Canada
ADDRESS . 11105 Bridge Street
Surrey British Columbia
Canada V3V 3V2
EMERGENCY TELEPHONE NO (S) . 604-580-2606

*** SUPPLIER INFORMATION ***

SUPPLIER/DISTRIBUTOR . The Synkoloid Company of Canada
ADDRESS 11105 Bridge Street
Surrey British Columbia
Canada V3V 3V2
EMERGENCY TELEPHONE NO (S) 604-580-2606

*** MATERIAL SAFETY DATA ***

POWDERED FILLERS AND TEXTURES

MATERIAL SAFETY DATA SHEET

SECTION 1 -- PRODUCT IDENTIFICATION AND USE

PRODUCT IDENTIFIER Synko Powdered Drywall Joint Cements and textures

Synko Pure Velvet	Synko Ruff-Tex
Synko Joint Cement	Synko Snow-Tex
Synko Imperial	Synko Stiro-Tex
Synko Jet-Set	Synko Super Ceiling
Synko Fast Set	Synko Wall-Tex
Synko Lite-Ning Set	Synko Ultra Span
Synko Concrete Fill	Synko Span Texture
Synko Acrilite	

PRODUCT USE Finishing and texturing of interior drywall and concrete surfaces

SECTION 2 -- HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	%	CAS NUMBER
Crystalline Silica LC50 N/AV LD50 N/AV	0 1-1 5 Weight/Weight	14808-60-7

SECTION 3 -- PHYSICAL DATA

PHYSICAL STATE Solid
VAPOR PRESSURE Not applicable
FREEZING POINT Not applicable
pH 7 8-10
SOLUBILITY IN WATER Slight, unlimited dispersibility
ODOR AND APPEARANCE Off-white powder with negligible odor May contain polystyrene or perlite aggregates

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EVAPORATION RATE Not applicable
BOILING POINT Not applicable
SPECIFIC GRAVITY 0 5-1 5
VAPOR DENSITY Not applicable

SECTION 4 -- FIRE AND EXPLOSION DATA

FLAMMABILITY No
SENSITIVITY TO IMPACT No
SENSITIVITY TO STATIC DISCHARGE. NO

SECTION 5 -- REACTIVITY DATA

These products are chemically stable, are compatible with other substances, are not reactive and do not form hazardous decomposition products.

SECTION 6 -- TOXICOLOGICAL PROPERTIES

ROUTE OF ENTRY INHALATION -- X SKIN CONTACT -- X SKIN ABSORPTION -- EYE CONTACT -- X INGESTION -- X
EFFECTS OF ACUTE EXPOSURE TO PRODUCT Irritation and soreness of throat and nose Contact with skin and eyes may cause irritation
EFFECTS OF CHRONIC EXPOSURE TO PRODUCT This product contains Crystalline Silica, which is considered a hazard by inhalation IARC has classified Crystalline Silica as probably carcinogenic for humans (2A). Crystalline Silica is also a known cause of silicosis, a non cancerous lung disease
EXPOSURE LIMIT TILV -- TWA [ACGIH] -- 0 1 mg/cu.m respirable dust
IRRITANCY OF PRODUCT[S] Not a sensitizer
SENSITIZATION TO PRODUCT Not a sensitizer
CARCINOGENICITY Not Carcinogenic [NIP and OSHA]
SYNERGISTIC PRODUCTS None known
MEDICAL CONDITION WHICH MAY BE AGGRAVATED Pre existing upper respiratory and lung disease such as, but not limited to Bronchitis, Emphysema and Asthma

SECTION 7 -- PREVENTIVE MEASURES

GLOVES Rubber gloves desirable to protect against drying of hands
RESPIRATOR Niosh approved dust/mist filter respirator
EYES Tight fitting safety goggles
FOOTWEAR Safety shoes
CLOTHING Body covering protective clothing
ENGINEERING CONTROLS Use sufficient ventilation to keep dust or mist to a minimum
LEAK AND SPILL PROCEDURE Vacuum, shovel or sweep spilled material into waste container for reuse or disposal
WASTE DISPOSAL As per local regulations
HANDLING PROCEDURES AND EQUIPMENT Do not get in eyes, on skin or clothing Wash thoroughly after handling Do not ingest.
-- use wet sponging in lieu of dry sanding whenever possible If sanding is absolutely necessary then keep dust to a minimum and wear a Niosh approved dust mask
-- keep out of reach of small children avoid contact with strong mineral acids
STORAGE REQUIREMENTS Store in dry area
SPECIAL SHIPPING INFORMATION None

SECTION 8 -- FIRST AID MEASURES

SPECIFIC MEASURES
INGESTION Seek prompt medical attention
INHALATION Remove to fresh air
SKIN CONTACT Wash with water and soap If irritation persists

obtain medical attention.
EYE CONTACT Remove contact lenses Rinse eyes [including under eyelids] for 10-15 minutes with copious quantities of clean water If irritation or mechanical injury occurs contact physician

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SECTION 9 -- PREPARATION DATE OF MSDS

PREPARED BY Synkoloid's R/D Department PHONE NUMBER [604] 580-2606
DATE July 1, 1990

SYNKO POWDERED DRYWALL JOINT CEMENTS AND TEXTURES

WHMIS CLASSIFICATION Class D -- Poisonous and Infectious Material 2 Materials Causing Other Toxic Effects

PRECAUTIONS Avoid skin and eye contact Avoid inhaling dust or mist For dusty conditions, use approved dust mask and adequate ventilation.
RISK Dust may cause eye and respiratory irritation Prolonged inhalation of excessive concentrations of crysalline silica, contained in this product may cause lung damage

FIRST AID Skin wash exposed area with soap and water Inhalation remove to fresh air Eye Contact wash eyes with running water for 15 minutes including under eyelids Ingestion get prompt medical attention

See material safety data sheet

THE SYNKOLOID COMPANY OF CANADA

1105 Bridge St	1030-34 Ave SE	11833-145 St	1350A Spruce St
Surrey, B C	Calgary, Alta	Edmonton, Alta	Winnipeg, Ma
V3V-3V2	T2G-1V4	T5L-2H4	R3E-2V7
(604) 580-2606	(403) 287-1360	(403) 453-1564	(204) 772-0428

M S D S

Canadian Centre for Occupational Health and Safety

*** IDENTIFICATION ***

RECORD NUMBER 281883
LANGUAGE ENGLISH
PRODUCT NAME(S) Synko pre-mixed drywall Joint Cements and Textures Synko Redi-filler Synko Lite Line Finish Synko Red Line Topping Synko Skim Coat Synko Red Line All Purpose Synko Redi-Tex Synko Lite Line All Purpose Synko Span-Lite Synko Lite Line Joint Cement
DATE OF MSDS : 1990-07-01

*** MANUFACTURER INFORMATION ***

MANUFACTURER : The Synkoloid Company of Canada
ADDRESS : 11105 Bridge Street
Surrey British Columbia
Canada V3V 3V2
EMERGENCY TELEPHONE NO (S) : 604-580-2606

*** SUPPLIER INFORMATION ***

SUPPLIER/DISTRIBUTOR : The Synkoloid Company of Canada

ADDRESS : 11105 Bridge Street
Surrey British Columbia
Canada V3V 3V2
EMERGENCY TELEPHONE NO (S) 604-580-2606

*** MATERIAL SAFETY DATA ***

PRE-MIXES
MATERIAL SAFETY DATA SHEET

SECTION 1 -- PRODUCT IDENTIFICATION AND USE

PRODUCT IDENTIFIER Synko pre-mixed drywall Joint Cements and Textures

Synko Redi-filler	Synko Lite Line Finish
Synko Red Line Topping	Synko Skim Coat
Synko Red Line All Purpose	Synko Redi-Tex
Synko Lite Line All Purpose	Synko Span-Lite
Synko Lite Line Joint Cement	

PRODUCT USE Finishing and texturing of interior drywall surfaces

SECTION 2 -- HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	%	CAS NUMBER
Crystalline Silica	0 1-1 5 Weight/Weight	14808-60-7
LC50 N/AV		
LD50 N/AV		

SECTION 3 -- PHYSICAL DATA

PHYSICAL STATE solid [paste]
VAPOR PRESSURE that of water
FREEZING POINT [C] 0
pH 7 8 - 10
SOLUBILITY IN WATER unlimited dispersability
ODOR AND APPEARANCE off-white paste with negligible odor
EVAPORATION RATE that of water
BOILING POINT [C] 100
SPECIFIC GRAVITY 1 1 TO 1 9 at 25 C
VAPOR DENSITY that of water

SECTION 4 -- FIRE AND EXPLOSION DATA

FLAMMABILITY No
SENSITIVITY TO IMPACT No
SENSITIVITY TO STATIC DISCHARGE No

SECTION 5 -- REACTIVITY DATA

These products are chemically stable, are compatible with other substances, are not reactive and do not form hazardous decomposition products.

SECTION 6 -- TOXICOLOGICAL PROPERTIES

ROUTE OF ENTRY INHALATION -- X SKIN CONTACT -- X SKIN ABSORPTION --
EYE CONTACT -- X INGESTION -- X
EFFECTS OF ACUTE EXPOSURE TO PRODUCT Irritation and soreness of throat and nose. Contact with skin and eyes may cause irritation
EFFECTS OF CHRONIC EXPOSURE TO PRODUCT This product contains Crystalline Silica, which is considered a hazard by inhalation IARC has classified Crystalline Silica as probably

carcinogenic for humans [2A] Crystalline Silica is also a known cause of silicosis, a non cancerous lung disease

EXPOSURE LIMIT TLV -- TWA [ACGIH] -- 0 1 mg/cu m respirable dust
IRRITANCY OF PRODUCT[S] Not a sensitizer
SENSITIZATION TO PRODUCT Not a sensitizer
CARCINOGENICITY Not carcinogenic [NIP and OSHA]
SYNERGISTIC PRODUCTS None known
MEDICAL CONDITIONS WHICH MAY BE AGGRAVATED· Pre existing upper respiratory and lung disease such as, but not limited to Bronchitis, Emphysema and Asthma

SECTION 7 -- PREVENTIVE MEASURES

GLOVES Rubber gloves desirable to protect against drying of hands
RESPIRATOR Niosh approved dust/mist filter respirator
EYES Tight fitting safety goggles
FOOTWEAR Safety shoes
CLOTHING Body covering protective clothing
ENGINEERING CONTROLS Use sufficient ventilation to keep dust or mist to a minimum
LEAK AND SPILL PROCEDURE Shovel spilled material into waste container for reuse or disposal
WASTE DISPOSAL As per local regulations
HANDLING PROCEDURES AND EQUIPMENT Do not get in eyes, on skin or clothing Wash thoroughly after handling Do not ingest
-- Use wet sponging in lieu of dry sanding whenever possible If sanding is absolutely necessary then keep dust to a minimum and wear a Niosh approved dust mask
-- Keep out of reach of small children
-- Avoid contact with strong mineral acids
STORAGE REQUIREMENTS Do not freeze Store in dry area where ambient temperature can be maintained between 3 and 30 C
SPECIAL SHIPPING INFORMATION Do not freeze

SECTION 8 -- FIRST AID MEASURES

SPECIFIC MEASURES
INGESTION Seek prompt medical attention
INHALATION Remove to fresh air
SKIN CONTACT Wash with water and soap If irritation persists obtain medical attention
EYE CONTACT Remove contact lenses, Rinse eyes [including under eyelids] for 10-15 minutes with copious quantities of clean water If irritation or mechanical injury occurs, contact physician

SECTION 9 -- PREPARATION DATE OF MSDS

PREPARED BY Synkoloid's R/D Department PHONE NUMBER [604] 580-2606
DATE July 1, 1990

SYNKO PRE-MIXED DRYWALL JOINT CEMENTS AND TEXTURES

WHMIS CLASSIFICATION Class D -- Poisonous and Infectious Material 2 Materials Causing Other Toxic Effects.

PRECAUTIONS Avoid skin and eye contact Avoid inhaling dust or mist For dusty conditions, use approved dust mask and adequate ventilation

RISK Dust may cause eye and respiratory irritation Prolonged inhalation of excessive concentrations of crysalline silica, contained in this product, may cause lung damage

FIRST AID Skin wash exposed area with soap and water Inhalation remove to fresh air Eye Contact wash eyes with running water for 15 minutes including under eyelids Ingestion. get prompt medical attention See material safety data sheet

THE SYNKOLOID COMPANY OF CANADA

1105 Bridge St	1030-34 Ave SE	11833-145 St.	1350A Spruce St.
Surrey, B C	Calgary, Alta.	Edmonton, Alta.	Winnipeg, Ma
V3V-3V2	T2G-1V4	T5L-2H4	R3E-2V7
(604) 580-2606	(403) 287-1360	(403) 453-1564	(204) 772-0428

Georgia-Pacific

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

PRODUCT NAME AND SYNONYMS: Ready Mix Joint Compound
Ready Mix Topping Compound

CAS NAME AND NO Mixture

CHEMICAL FAMILY: Not Applicable

CHEMICAL FORMULA: Not Applicable

MANUFACTURER'S NAME AND ADDRESS: Georgia-Pacific Corporation
2861 Miller Road
Decatur, GA 30035

EMERGENCY TELEPHONE NO.: (404) 987-5190 or
(800) 424-9300 CHEMTREC

SECTION II - HAZARDOUS INGREDIENTS

COMPONENT (CAS Registry No.)	WT. %	ACGIH TLV® (TWA)	OSHA PEL (TWA)
Gypsum/Calcium Sulfate (7778-18-9)** or Limestone/Calcium Carbonate (1317-65-3)**	44-95	*10 mg/m^3	15 mg/m^3(1) 5 mg/m^3(2)
Starch (9005-25-8)	0-1.2	*10 mg/m^3	15 mg/m^3(1) 5 mg/m^3(2)
Perlite (No CAS #)	0-2.7	*10 mg/m^3	15 mg/m^3(3) 5 mg/m^3(2)

* Total dust containing no asbestos and < 1.0% free crystalline silica.
** Gypsum and limestone may contain crystalline silica as trace, naturally occurring contaminant; usually present at < 1.0%.
(1) Total dust.
(2) Respirable dust.
(3) Value is for total particulate containing < 1.0% quartz.

SECTION III - PHYSICAL PROPERTIES

APPEARANCE AND ODOR: Whitish, paste-like compound; low odor.

MOLECULAR WEIGHT: Not Applicable

BOILING POINT (DEGREES FAHRENHEIT): Not Applicable

MELTING POINT (DEGREES FAHRENHEIT): Not Applicable

VAPOR PRESSURE (MM. OF MERCURY): Not Applicable

SPECIFIC GRAVITY (WATER = 1): 1.0 - 2.5

VAPOR DENSITY (AIR = 1): Not Applicable

PERCENT VOLATILE (BY WEIGHT): Not Applicable

pH: Products with Portland cement, calcium hydroxide or high limestone content: 8.5 - 10
Other products with high gypsum content: 7 - 8

SOLUBILITY IN WATER: Not Applicable

EVAPORATION RATE (BUTYL ACETATE = 1): Not Applicable

SECTION IV - FIRE AND EXPLOSION DATA

FLASH POINT: Not Applicable

FIRE EXTINGUISHING MEDIA: Non-combustible

FLAMMABLE LIMITS (PERCENT BY VOLUME):	LOWER	UPPER
	N/A	N/A

SPECIAL FIRE FIGHTING PROCEDURES & EQUIPMENT: None

UNUSUAL FIRE AND EXPLOSION HAZARDS: None

SECTION V - REACTIVITY DATA

STABILITY: UNSTABLE ____ STABLE X

CONDITIONS TO AVOID: None

INCOMPATIBILITY (MATERIALS TO AVOID): None

HAZARDOUS DECOMPOSITION PRODUCTS: None

HAZARDOUS POLYMERIZATION: WILL OCCUR ____ WILL NOT OCCUR X

CONDITIONS TO AVOID: None

SECTION VI - HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: This material is not known to be toxic. Persons exposed to large amounts of dust may be forced to leave area because of nuisance conditions, including coughing, sneezing and nasal irritation. Other temporary effects may include:

A17

skin - may dry skin.
eyes - Particles may cause irritation.

PROBABLE ROUTES OF EXPOSURE: Inhalation, skin, eyes.

EMERGENCY AND FIRST AID PROCEDURES:

INGESTION: If swallowed, no specific intervention is indicated, as the product is not likely to be hazardous by ingestion. However, consult a physician if necessary.

INHALATION: Remove to fresh air.

EYE CONTACT: Remove contact lenses. Rinse eyes with plenty of running water for 10-15 minutes, including under eyelids. If irritation occurs, contact physician.

SKIN CONTACT: Wash promptly with water. If irritation occurs, contact physician

SECTION VII - TOXICITY DATA

ORAL: not available

DERMAL This material is not an irritant when applied to the skin of rabbits under the Federal Hazard Substances Act (FHSA) criteria. This material is not lethal when applied to the skin of rabbits under the FHSA criteria.

INHALATION: This material is not toxic to rats by inhalation under the FHSA criteria

CARCINOGENICITY The gypsum used in these products may contain natural, trace amounts of crystalline silica (usually less than 1.0%) Some of the dust created by cutting, trimming, or processing of the product may contain low concentrations of silica, some of which may be respirable. Prolonged exposure to crystalline silica has been known to cause silicosis, a lung disease which may be disabling. While there may be a factor of individual susceptibility to a given exposure to respirable silica dust, the risk of contracting silicosis and the severity of the disease is clearly related to the amount of dust exposure and the length of time (usually years) of exposure.

Crystalline silica has been classified by the International Agency for Research on Cancer (IARC) as a probable human carcinogen (Group 2a) with animal evidence sufficient. Respirable crystalline silica has been classified by the National Toxicology Program (NTP) as a substance which may be reasonably anticipated to be a carcinogen It is not considered to be a human carcinogen by the American Conference of Governmental Hygienists (ACGIH) or the Occupational Safety and Health Administration.

OTHER PERTINENT DATA This material is not an eye irritant when applied to the eyes of rabbits under the FHSA criteria.

SECTION VIII - SPECIAL PROTECTION INFORMATION

PERSONAL PROTECTIVE EQUIPMENT

PROTECTIVE GLOVES: Not Applicable

EYE PROTECTION: When dry sanding, wear dust goggles. Use wet sponging in lieu of dry sanding whenever possible

RESPIRATORY PROTECTION (SPECIFY TYPE): When dry sanding, wear NIOSH-approved respirator. Use wet sponging in lieu of dry sanding whenever possible.

OTHER PROTECTIVE EQUIPMENT: Not Applicable

VENTILATION

LOCAL EXHAUST: As necessary to avoid dusting conditions.

MECHANICAL (GENERAL): Not Applicable

SPECIAL Not Applicable

OTHER: Not Applicable

SECTION IX - SPILL, LEAK AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Sweep or vacuum spilled material into a waste container for disposal. Do not wash down drains - may plug drains.

WASTE DISPOSAL METHODS: May be disposed of as inert solid in sanitary landfill or by other procedures in accordance with all federal, state and local regulations.

CLEAN WATER ACT REQUIREMENTS: Not Applicable

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) REQUIREMENTS: Not Applicable

SECTION X - REGULATORY INFORMATION

FDA: Product is manufactured for use as building construction material or other industrial applications. As such, FDA regulations are not deemed applicable.

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USDA: Not Applicable

CPSC: Not Applicable

TSCA: Product is a mixture, and therefore is not subject to TSCA reporting requirements.

DOT: Not regulated

PROPER SHIPPING NAME: Not Applicable

HAZARD CLASS: Not Applicable

LABEL REQUIRED: Not Applicable

IDENTIFICATION NO.: Not Applicable

OTHER PERTINENT INFORMATION: Not Applicable

SECTION XI - SPECIAL PRECAUTIONS AND COMMENTS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Be sure proper ventilation and respiratory and eye protection are used under dusting conditions.

OTHER PRECAUTIONS: Excessive particulate in workplace air should be avoided. Where applicable, use wet sponging in lieu of dry sanding whenever possible.

REGISTRATION/CERTIFICATIONS. Not Applicable

EFFECTIVE DATE. 4/8/92 SUPERSEDES 4/8/91

IMPORTANT: The information and data herein are believed to be accurate and have been compiled from sources believed to be reliable. It is offered for your consideration, investigation and verification. Buyer assumes all risk of use, storage and handling of the product in compliance with applicable federal, state and local laws and regulations. GEORGIA-PACIFIC MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, CONCERNING THE ACCURACY OR COMPLETENESS OF THE INFORMATION AND DATA HEREIN. THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE SPECIFICALLY EXCLUDED. Georgia-Pacific will not be liable for claims relating to any party's use of or reliance on information and data contained herein regardless of whether it is claimed that the information and data are inaccurate, incomplete or otherwise misleading.

** TOTAL PAGE.005 **

MATERIAL SAFETY DATA SHEET

KADEX CORPORATION OF INDIANA
420 East Brackenridge, Fort Wayne, In. 46802

Date: December 10, 1985 No. 102 Phone: 219-423-3380

PRODUCT NAMES

Ready to Use - (Liquids)	Powders
All Purpose Compound	Triple 300 All Purpose
Taping Compound	Taping Cement
Topping Compound	Topping Cement
Synthetic All Purpose Compound	
Synthetic Topping Compound	

Chemical Type: Mixtures of inorganic minerals and minor additives.

HAZARDOUS INGREDIENTS

Limestone (calcium carbonate)
Mica (silicon dioxide)
Talc (calcium magnesium silicate)
Starch (carbohydrate)

FIRE AND EXPLOSION PROPERTIES

Non-combustible. Non-explosive.
No dangerous reactions with extinguishing media.

PHYSICAL PROPERTIES

Appearance: White to off-white powder or liquid.
Water solubility: slight
pH: slightly alkaline
Specific Gravity (water=1):>1

HEALTH HAZARDS - FIRST AID - PROTECTIVE MEASURES

OSHA TWA/TLV for above Products (nuisance dust limit):
15 mg/m^3 (total dust), 5 mg/m^3 (respirable dust).

Inhalation: Prolonged inhalation of excessive dust may cause delayed lung injury.
If adverse effects occur get medical attention.
Wear approved dust respirator when dust is present.

Skin: May cause irritation and drying of skin.
Wash with soap and water.
Wear protective gloves and clothing.

Eyes: May cause irritation.
Flush with water for at least 15 minutes.
If adverse effects persist get medical attention.
Wear dust goggles if continually affected.

Ingestion: Drink plenty of water. No acute toxic effects are indicated based on ingredients.

HANDLING INFORMATION

Keep powders dry and liquids covered to prevent premature hardening.
Reduce dust as much as possible, such as by ventilation and/or shielding of work area.
Stable and non-reactive except for hardening when powder is wetted or liquids dry out.

WASTE DISPOSAL AND SPILLS

Dispose of in sanitary landfill in accordance with local, state, and federal regulations. Note that wet material can harden.

If spilled, reuse immediately if practical, or take to disposal. Minimize creating dust; wear dust respirators. Do not flush down sewer drains (plugging may occur) unless greatly diluted with water.

The information herein has been compiled from sources believed to be reliable and is accurate to the best of our knowledge. However, KADEX Corporation cannot give any guarantees regarding information from other sources, and expressly does not make any warranties, nor assumes any liability, for its use.

APPENDIX B: BULK SAMPLE ANALYSIS OF DRYWALL COMPOUND

The laboratory analysis described in this appendix was performed on bulk drywall compound samples which were collected at job locations in Philadelphia, Pennsylvania during June 1994

DEPARTMENT OF HEALTH & HUMAN SERVICES

Memorandum

Date August 15, 1994

From Chemist, MDS, MRSB

Subject Sequence 8018A; ECTB 94-4389: The Quantitative Determination of Silica by XRD

To Leroy Mickelsen, ECTB Lab Coordinator
Attn· Ken Mead
Through: Acting Director, DPSE 8/15/94
Chief, MRSB, DPSE

INTRODUCTION:

Three dust samples were collected at the in Philadelphia, Pa and were submitted for silica analysis by X-ray powder diffraction (XRD) and talc analysis. Qualitative X-ray diffraction and polarized light microscopy were previously used to determine if these materials were present. As reported on 7/19/94, the samples contained no talc but minor amounts of quartz were detected

EXPERIMENTAL:

Duplicate 3 mg aliquots of each sample were weighed and then placed in 50 mL Griffin beakers with 20 ml isopropanol. They were sonicated to form a suspension, and deposited on 25 mm 0 45 micron silver filters for quartz analysis. The samples were scanned from 25 6° to 27 6° (2-theta) at a rate of 0 02°/second for the primary quartz peak on a Philips difractometer at 40 kV, 35mA and compared to known amounts of pure quartz This is a modification of NIOSH Method 7500 used for bulk samples

RESULTS:

The results are reported on the attached data sheet as average (n=2) percent silica quartz by weight. The limit of detection for this sample set was 1.2 percent. The limit of quantitation was 3.6.

Mark Millson

John L. Holtz
Chief, MDS, MRSB, DPSE

Attachment

SEQUENCE 8018 A

SIO2

Percent by Weight

SAMPLE	SILICA (quartz)
MSB 15	2.2
PHA 16	5.6
PHA 17	6.0

Date of Analysis: 8/10/94

DEPARTMENT OF HEALTH & HUMAN SERVICES

Memorandum

Date July 19, 1994

From Physical Scientist, MDS, MRSB, DPSE

Subject Sequence #8018B; ECTB 94-4389: Microscopic and X-Ray Analysis of Three (3) Bulk Samples.

To Leroy Michelson, ECTB Lab Coordinator
Attn: Ken Mead
Through: Acting Director, DPSE 7/19/94
Chief, MRSB, DPSE

INTRODUCTION:

Three bulk samples, collected during drywall sanding in Philadelphia, Pennsylvania, were submitted for asbestos, talc and quartz analysis by polarized light microscopy (PLM) and X-ray diffraction (XRD)

EXPERIMENTAL:

After ensuring homogeneity, portions of the samples were immersed in Cargille Liquids and analyzed on the Olympus PLM at magnifications of 100 and 200X. The remainder of the samples were then ultrasonicated in isopropanol. Aliquots of each sample were then deposited on silver filters and analyzed on the Philips XRD A qualitative program was used that scanned from 4 to 80 degrees 2-theta at a rate 0 020 degrees per second Copper k-alpha radiation at 40kv and 35ma was used. Diffraction data were then compared to internally stored standards for phase identification

RESULTS:

No asbestos or talc was detected on any of the samples by either PLM or XRD. Minor amounts of quartz were detected by both methods on each of the samples. Analyses were performed on July 1, 1994.

Joseph E. Fernback

for John L Holtz
Chief, MDS, MRSB, DPSE

APPENDIX C COMMERCIALLY AVAILABLE ENGINEERING CONTROLS

A total of five control combinations were identified and studied as part of this experimental evaluation In addition, a sixth sanding control, the Dustless Drywall Machine (DDM), was discovered after arriving at the evaluation site However, we were unable to incorporate the DDM into the already-designed experimental protocol Source information for the DDM control is also included in this appendix This appendix lists the commercially available controls which we were able to identify during the time frame of this study and is not an intended to be an endorsement of product or manufacturer Additional drywall sanding controls may exist which were not part of this list Their exclusion in no way reflects upon their product

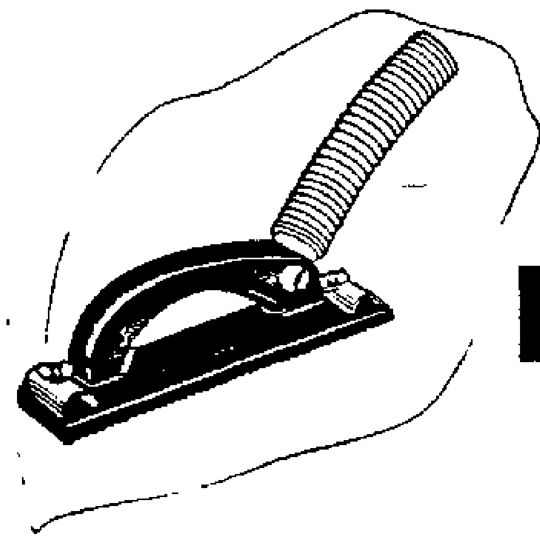
TOOL NAME	CONFIGURATION	PURCHASE PRICE PAID*
FibaTape	Hand sanding head only	$15 00
"Sand Duster kit"	Pole sander w/hose	$170 00
"Sand Duster/Quiet Vac" System	Pole sander, hose, "never-clog prefilter, "Quiet Vac" vacuum kit	$800 00
Sand & Kleen Hand Sander Kit	Hand sander, water filter, & hose	$70 00
Sand & Kleen Pole Sander Kit	Pole sander, water filter, & hose	$110 00
Sand & Kleen Combo Kit	Both sanders, filter, & hose	$120 00
DDM Kit	Pole sander & hose	$467 00
DDM Model 600	Kit plus Clark M600 Vac	$1186 00
DDM Model 900	Kit plus Clark M900 Vac	$1812 00

* Prices listed reflect the prices in effect at the time of the experimental evaluation

Vacuum Drywall Sander

FibaTape

New Product: For Dustless Drywall Sanding



FibaTape®

Professional

VACUUM DRYWALL SANDER

FOR USE WITH WET/DRY SHOP VACUUM CLEANERS

Messy drywall dust problems are virtually eliminated with the *FibaTape®* **Professional Vacuum Drywall Sander** Designed for use with a standard wet/dry shop vacuum and "open-mesh" abrasive sanding screen, this Vacuum Sander captures even the finest dust particles as the wall is being sanded

The Vacuum Drywall Sander features

- Specially engineered rubber sole plate which effectively draws dust from every corner of the sanding surface
- Patented variable suction control valve to adjust vacuum action - accommodates both homeowner and professional quality wet/dry shop vacuum cleaners
- 6" flexible hose adapter accommodates various brands of shop vacuums (fits 1 1/4" hose - for cleaners with larger hose diameter, an adapter available from the manufacturer is required)
- Complete illustrated instructions included

Prod code	Description	Case Pack	Case Weight	Case Cube	UPC Code #
SV303U	FibaTape® Vacuum Drywall Sander	6 / case	15 lbs	1 57 cu ft	0 38662 51110 7

Designed for use with sanding screen

44?? Eastgate Blvd - Cincy

Perma Glas-Mesh
Incorporated

A Bay Mills Company
P O Box 220, Dover OH 44622
Toll Free Help Line 1-800-762-6694 Fax (216) 343-8543

Builder's Square

OPERATING INSTRUCTIONS:

Follow these easy-to-use instructions and virtually eliminate the unpleasant problems associated with dust created during drywall finishing

STEP ONE: What do you need?

1 ***FibaTape®*** **Vacuum Drywall Sander with 6" adapter hose and unique adjustable suction control valve**

2 A wet/dry shop vacuum equipped with a standard ***1 1/4" diameter vacuum hose***, a filter bag over the sponge filter and a paper dust bag supplied by the shop vacuum dealer The paper dust bag will totally contain the drywall dust and make disposal easy An extension hose supplied by the vacuum shop dealer may make it easier to reach higher when sanding

*3. **FibaTape®*** brand sanding screen (or equivalent) The openings in the screen resist clogging by allowing the dust to be channeled through the screen, up and into the directional grooves of the rubber sole plate and into the vacuum system Sanding screen can last significantly longer than traditional sanding paper

Caution: A filter mask and protective eye wear should always be used for extra protection whenever finishing drywall.

STEP TWO: Attach the Vacuum Drywall Sander to your wet/dry shop vacuum.

1.Attach the hose of your wet/dry shop vacuum over the gray tail pipe/exhaust valve If it does not fit, attach the flexible adapter hose to the Vacuum Hand Sander and try again

STEP THREE: Fasten the Sanding Screen to the Vacuum Drywall Sander

1 Loosen the wing nuts on the metal clips at each end of the Vacuum Sander

2 Insert one end of the die cut sanding screen 1/2" under the metal clip, keeping the screen centered on the tool Tighten the wing nut just until the screen is held firmly Do not overtighten

3 Wrap sanding screen around the base of the sander, keeping snug against the bottom Insert the end of the sanding screen under the other metal clip, and tighten the wing nut as above

Note If sanding screen is not available in die-cut sheets, regular sanding screen sheets may be cut into pieces 3 5/16" wide by 11" long

STEP FOUR: Sanding with the *FibaTape®* Vacuum Hand Sander

1 Turn on the wet/dry shop vacuum and begin sanding

2 Keep the sander flat against the surface being sanded Tilting the sander will cause the suction to be broken and the heavy particles will fall to the floor The airborne dust will still be captured

STEP FIVE: Adjusting for Correct Suction:

1 The gray exhaust/tail pipe of the *FibaTape®* Drywall Vacuum Sander also acts as an adjustable suction valve Simply rotate the gray tail pipe exposing more or less of the valve opening depending on the desired effect When the hole is fully closed the suction to the sanding surface is at maximum, and when fully open, at minimum

2 The suction should be adjusted so that noticeable suction is applied to the sanding surface with the sanding screen installed, but not so much that there is resistance to the sanding motion.

3 The valve may be stiff to turn at first It will turn more freely as you use it over time

NOTE:

The *FibaTape® Vacuum Hand Sander* must be used with sanding screen rather than conventional sand paper The open holes in the mesh are required to allow the vacuum to pick up the drywall dust

WARNING The *FibaTape® Vacuum Hand Sander* is intended for use with wet/dry type shop vacuums. Do not use with a standard household vacuum cleaner Damage may occur to the cleaner mechanism.

Perma Glas-Mesh
Incorporated

A Bay Mills Company
P O Box 220, Dover OH 44622
Toll Free Help Line. 1-800-762-6594 Fax (216) 343-8543

REE 30 DAY TRIAL OFFER

DUST FREE DRYWALL SANDING

No matter what environment you're working in, chances are you need a way to eliminate dry wall dust from your work space Now, the solution is here.

Introducing the Sanduster™. It's the ultimate dustless dry wall sanding tool that will

- Eliminate dry wall dust from the workspace
- Eliminate need for poly barriers
- Reduce clean-up time
- Eliminate need for dust masks
- Increase productivity
- Provide environmental safety

sanduster™

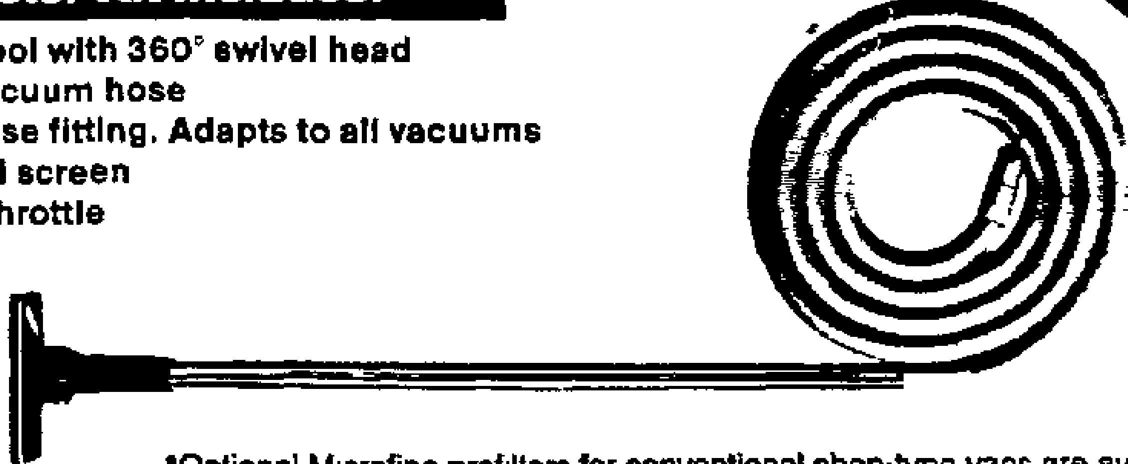
The Sanduster™ Dust Removal System from Hyde & Meeks Industries, Inc

H03

FREE 30 DAY TRIAL OFFER

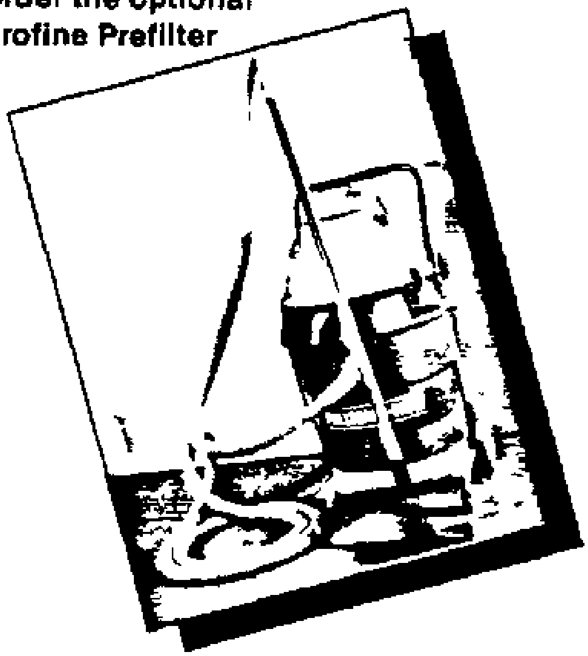
The Sanduster Kit Includes:

- Sanduster tool with 360° swivel head
- 17 feet of vacuum hose
- Universal hose fitting. Adapts to all vacuums
- 5 sheet sand screen
- Adjustable throttle



- If you are using your Shop Vac be sure to order the optional Microfine Prefilter

*Optional Microfine prefilters for conventional shop-type vacs are available.



The Sanduster System Includes:

- The Sanduster Kit
- Baffled motor for quiet operation (only 68 decibels)
- A 2 year warranty on the vacuum
- Special patented filter assembly with the "never clog filter"
- A convenient carry-all tool basket
- Four wheel dolly-style carriage

CALL (617) 646-9004 TO ORDER TODAY!

HYDE & MEEKS INDUSTRIES, INC
26 DUDLEY STREET
ARLINGTON, MA 02174

ORDER FORM

TELEPHONE (617) 646-9004
FAX (617) 643-9412

BILL TO			SHIP TO		
COMPANY NAME			COMPANY NAME		
ADDRESS			ADDRESS		
CITY	STATE	ZIP	CITY	STATE	ZIP
AUTHORIZED SIGNATURE	DATE		ATTENTION	TELE	
TITLE	P O #				

	REGULAR PRICE	QUANTITY	TOTAL
FREE TRIAL OFFER ON SANDUSTER KIT TRY FOR 30 DAYS - IF NOT SATISFIED RETURN AT NO CHARGE - SHIPPING PAID BOTH WAYS	N/C		
"SANDUSTER" KIT	$169 75		
"SANDUSTER/QUIET VAC" SYSTEM	$799 00		
MICROFINE PREFILTER FOR CONVENTIONAL SHOP-TYPE VACS	$30 00		
SHIPPING AND HANDLING $10 ON "SANDUSTER" KIT $30 ON "SANDUSTER/QUIET VAC" SYSTEM			
MA RESIDENTS ADD 5% SALES TAX			
GRAND TOTAL			

Hyde & Meeks Industries, Inc.

Tool Manufacturer

26 Dudley Street, Arlington, MA 02174 Telephone (617) 646-6470 Fax (617) 643-9412

SANDUSTER KIT
OPERATION AND MAINTENANCE INSTRUCTIONS

SANDUSTER IS A DRYWALL SANDING TOOL WHICH WHEN USED WITH THE PROPER VACUUM CLEANER WILL REMOVE MOST OF THE DUST CREATED DURING THE SANDING OF THE DRYWALL JOINTING COMPOUND.

DO NOT OPERATE THE SANDUSTER DUSTLESS SANDING TOOL UNTIL YOU HAVE CHECKED YOUR VACUUM TO DETERMINE IF THE FILTERS ARE CLEAN AND UNCLOGGED, MOTOR IS SECURELY ATTACHED TO VACUUM BODY, UNIT IS PROPERLY PLUGGED IN, AND SANDUSTER HOSE IS SECURELY ATTACHED TO THE VACUUM CLEANER.

OPERATION

A. INSTALLING SANDUSTER TO VACUUM CLEANER -

1. SANDUSTER COMES WITH A 1 1/4" FLEXIBLE VINYL HOSE WITH A 1 1/4" X 1 1/2" AND A 1 1/4" X 2 1/4" ADAPTOR CUFF. THESE FITTINGS ARE MADE TO FIT ETHER A 1 1/4" OR 1 1/2" STANDARD VINYL HOSE. TO FIT AN 1 1/2" HOSE SIMPLY PLACE THE TAPERED END OF THE SANDUSTER FITTING INSIDE THE 1 1/2" HOSE END AND PUSH TOGETHER. IF YOUR VACUUM CLEANER HAS ANOTHER SIZE HOSE, ADAPTORS ARE AVAILABLE THROUGH YOUR LOCAL SANDUSTER DEALER OR CALL THE MANUFACTURER HYDE & MEEKS INDUSTRIES AT 617-646-9004.
2. SANDUSTER IS ADAPTABLE FOR USE WITH ANY TYPE VACUUM CLEANER. HOWEVER IT IS BEST USED WITH A WET DRY OR BY-PASS VACUUM WERE THE MOTOR IS NOT BEING COOLED BY THE VACUUM DISCHARGE BUT IS BEING COOLED SEPARATELY. ON VACUUM WHERE THE MOTOR COOLING IS BEING DONE WITH THE VACUUM DISCHARGE - MOTOR DAMAGE CAN RESULT WHEN THE FILTER BECOMES CLOGGED AND THE DISCHARGE IS NOT SUFFICIENT TO COOL THE MOTOR. FURTHER IF THE FINE DUST PARTICLES ARE ALLOWED TO PASS THROUGH THE FILTER THEY CAN DAMAGE THE MOTOR.
3. SANDUSTER IS ONLY AS GOOD AS THE VACUUM CLEANER IT IS BEING ATTACHED TO. FOR BEST RESULTS WE RECOMMEND THE USE OF A VACUUM CLEANER WITH A MULTI-STAGE FILTRATION SYSTEM COMBINED WITH A DACRON BAG FILTER. THESE FILTRATION SYSTEMS ARE AVAILABLE FOR MOST SHOP TYPE VACUUM CLEANERS FROM THE VACUUM CLEANER MANUFACTURER. ON VACUUM CLEANERS WITH PAPER OR FOAM FILTERS WE RECOMMEND THAT THEY BE CLEANED FREQUENTLY TO AVOID DAMAGE TO THE MOTOR AND DISCHARGE OF THE FINE DRYWALL DUST INTO THE AIR.

B. INSTALLING THE SANDSCREEN

1. SANDSCREEN IS INSTALLED ON THE SANDUSTER TOOL BY PLACING THE PRE-CUT SANDSCREEN OVER THE PERFORATED

Hyde & Meeks Industries, Inc.

Tool Manufacturer

26 Dudley Street, Arlington, MA 02174 Telephone (617) 646-6470 Fax (617) 643-9412

SANDUSTER KIT
OPERATION AND MAINTENANCE INSTRUCTIONS

FOAM RUBBER PAD AT THE BOTTOM OF THE TOOL, TURNING THE TABS OF THE SANDSCREEN UP AND PLACING THE RETAINER CLIPS OVER THE SANDSCREEN TABS AND TIGHTEN DOWN THE WING NUT OVER THE RETAINER CLIPS.

2. AFTER SANDING WITH THIS TOOL. THE FACE OF THE SANDSCREEN WILL BECOME WORN AND WILL BE READY TO BE REPLACED. PLEASE NOTE SANDSCREEN CAN BE TURNED OVER AND USED ON THE OTHER FACE BEFORE IT NEEDS TO BE REPLACED.
3. WE HAVE INCLUDED 5 SHEETS OF 120 GRIT PRE-CUT SANDSCREEN IN EACH SANDUSTER KIT. ADDITIONAL OR REPLACEMENT SHEETS CAN BE PURCHASED THRU YOUR LOCAL SANDUSTER DEALER OR THROUGH HYDE & MEEKS INDUSTRIES.

C. OPERATION OF THROTTLE

1. THE THROTTLE IS THE FOAM RUBBER GRIP LOCATED AROUND AND AT BASE OF THE POLE. THIS GRIP OR THROTTLE IS MADE TO MOVE UP AND DOWN THE POLE THERE-BY EXPOSING THE VACUUM RELIEF HOLES IN THE POLE AND CONTROLLING THE AMOUNT OF SUCTION AT THE HEAD OF THE TOOL. WE RECOMMEND THAT YOU START WITH THE THROTTLE IN THE OPEN POSITION WITH ALL OF THE RELIEF HOLES EXPOSED. AS YOU CONTINUE TO SAND THE VACUUM CLEANER FILTER WILL BECOME CLOGGED THERE-BY DECREASING THE SUCTION AT THE HEAD AND INCREASING THE NEED TO CLOSE UP THE VACUUM RELIEF HOLES. AS THIS HAPPENS IT IS BEST TO CLOSE UP ONE SET OF THE VACUUM RELIEF HOLES AT A TIME. WHEN THEY ALL HAVE BEEN CLOSED UP WITH THE THROTTLE PUSHED TO THE BASE OF THE TOOL, IT IS TIME TO SHUT THE VACUUM CLEANER OFF AND CLEAN THE FILTERS OUT. AFTER THE VACUUM FILTERS HAVE BEEN CLEANED, YOU MAY START SANDING AGAIN WITH THE THROTTLE IN THE OPEN POSITION AND REPEAT THE OPERATION AS DESCRIBED ABOVE.

IF YOU ARE NOT USING A VACUUM OTHER THAN THE SPECIALLY DESIGNED UNIT SOLD BY HYDE & MEEKS INDUSTRIES, INC., YOU SHOULD TAKE GREAT CARE IN ASSURING THAT THE FILTER IN YOUR VACUUM IS NOT CLOGGED WITH DUST. IF THE FILTER IS ALLOWED TO CLOG VACUUM MOTOR DAMAGE MAY OCCUR. TO AVOID VACUUM MOTOR DAMAGE THE FILTER SHOULD BE INSPECTED / CLEANED OFTEN. WE RECOMMEND THAT THE FILTER BE CLEANED EVERY 15 TO 20 MINUTES OF USE.

Magna Industries, Inc.

P.O BOX 734 • CLEVELAND, OHIO 44107
2201 W 110th ST. • CLEVELAND, OHIO 44102
Toll Free (800) 969-3334 Phone (216) 251-3334
FAX 216 251-7778

January, 1993

Dear Friend,

Thank you so much for your interest in the SAND&KLEEN Dustless Dry Wall Sanding System you saw recently in a magazine.

We've enclosed an information sheet and a special price order form for your review.

As you can see, when you order direct from our factory, we're offering very special pricing as a 'thank you'. This offer is good through May, 1993.

The response to SAND&KLEEN has been very positive. We've sold over 5,000 units to a lot of very satisfied customers. SAND&KLEEN eliminates the need for dust masks and hours of clean up by removing the dust from joint compound sanding as you sand Even those with asthma or other respiratory problems can dry wall sand easily with SAND&KLEEN.

Again, thanks for your interest. If you need additional information or want to place an order when using a credit card, please call our toll free number during business hours Or you can Fax your order to 1-216-251-7778,
24 hours a day

Cordially,

Colleen Jones

Colleen Jones
Sales Assistant

encs

Magna.
Industries, Inc.
P O BOX 734 · CLEVELAND, OHIO 44107
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THE SAND&KLEEN PROFESSIONAL POLE SANDER SYSTEM

IS NOW AVAILABLE

SAND&KLEEN now offers a Professional Style Pole Sander System that includes a unique design Pole Sander head with a swivel fitting for flexibility The head is made of lightweight cast aluminum and contains a special suction hose that removes dust from the sanding surface as you sand A special hose attachement behind the aluminum telescoping extension pole carries the dust to the Aquair Filter The extension pole of the Pole Sander extends from 2 foot to 4 foot

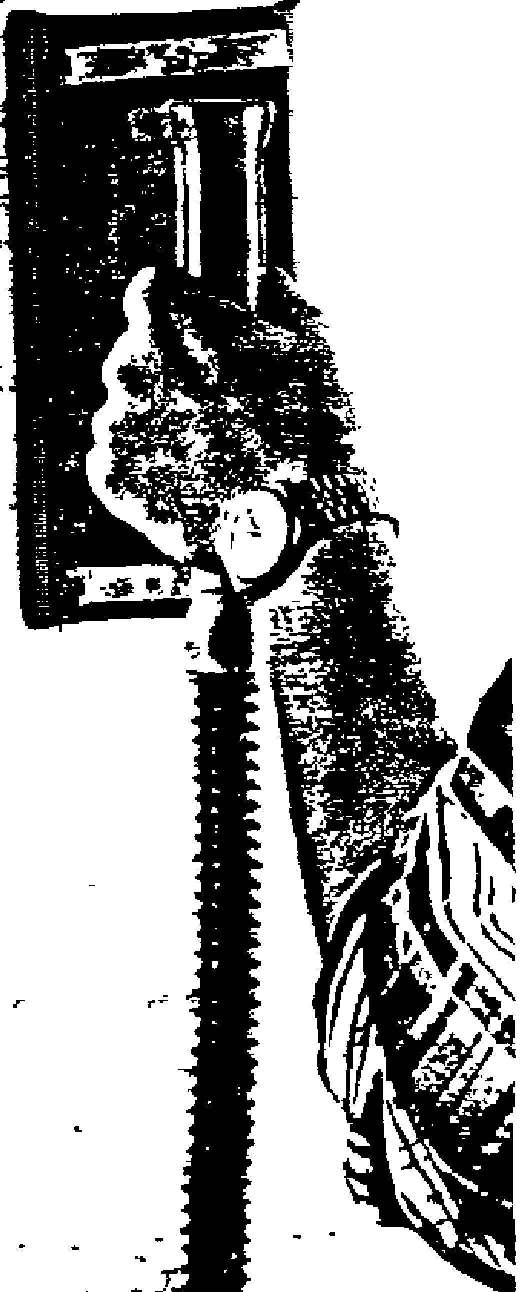
The SAND&KLEEN Pole Sander is ideal for sanding both walls and ceilings The Pole Sander is designed for high production jobs dones by both professionals and skilled do-it-yourselfers Both models of SAND&KLEEN use popular abrasive sanding screens available at home improvement stores everywhere.

The Pole Sander joins the SAND&KLEEN Hand Sander to eliminate 95% of the dust of dry wall sanding as you sand The Pole Sander System has a suggested retail of $119.95, the Hand Sander System sells for $74.99

##

Magna® SAND&KLEEN™

THE DUSTLESS DRY WALL SANDING SYSTEM



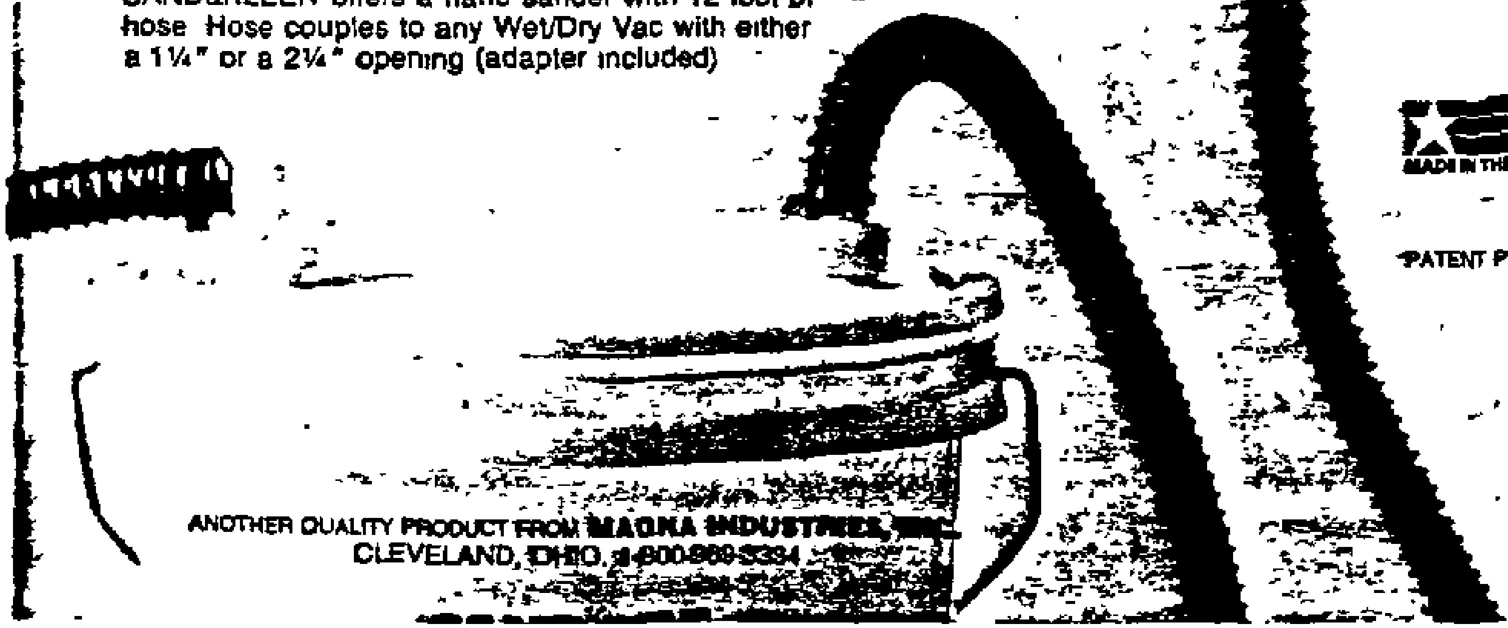
DRY WALL FINISHING—THE NEW WAY

SAND&KLEEN MAKES DRY WALL SANDING A CLEAN JOB!

SAND&KLEEN eliminates the need for sealing off work areas before sanding and reduces clean up! When your sanding is finished, your job is finished

SAND&KLEEN, an exclusive patented design, combines the features of a standard joint compound sander with the power of your vacuum cleaner 36 suction ports remove dust while you sand The AQUAIR *filter traps dust safely before it reaches* your vacuum system using tap water and no chemicals! Vacuum away joint compound dust during the sanding process and eliminate airborne dust completely SAND&KLEEN eliminates the need for nuisance masks or respirators

SAND&KLEEN offers a hand sander with 12 foot of hose Hose couples to any Wet/Dry Vac with either a 1¼" or a 2¼" opening (adapter included)



MADE IN THE U.S.A.

*PATENT PENDIN

ANOTHER QUALITY PRODUCT FROM MAGNA INDUSTRIES, INC.
CLEVELAND, OHIO 1-800-869-5394

SAND&KLEEN FACTORY DIRECT
ORDER FORM

ORDER YOUR SAND&KLEEN DUSTLESS DRY WALL SANDING SYSTEM DIRECT FROM THE FACTORY. FILL IN ALL INFORMATION COMPLETELY. SHIPMENTS WILL BE PREPAID FROM CLEVELAND, OHIO.

Model No.	Description	SUGGESTED RETAIL PRICE	SPECIAL PRICE	QUANTITY	EXTENSION
MT 800	SAND&KLEEN Hand Sander Kit	74 95	69 95		
MT 850	PROFESSIONAL Pole Sander Kit	119.95	109 95		
MT 891	Abrasive Screen (2 Sheet Pak) #120 Grit ✗	3.00	3 00		
MT 875	12 Ft. Extension Hose with Fittings	19 95	19 95		
MT 880	Replacement Rubber Pad and Plastic Shell	7.95	7.95		
MT 999	Pole Sander with Extension Pole ONLY	69.95	69 95		
MT 890	SAND&KLEEN COMBO KIT HS ✗	149.95	119 95		

SUB TOTAL	
Sales Tax	
Ship & Handling	5 00
TOTAL	

Mastercard No. ____________________

VISA No ____________________

Exp. Date: ____________________

SHIP TO *Please Print Clearly*

Name ____________________

Address ____________________

City, State, Zip Code ____________________

TOTALS

Please check all figures and enter correct amount

Ohio residents please add correct Sales Tax for Ohio (7%)

Please allow 4 to 6 weeks for delivery

Please DO NOT send cash with this order form Make Check or Money Order payable to Magna Industries, Inc All prices are in U S Funds

Mail this form to. **Magna Industries, Inc.**
2201 West 110th Street
Cleveland, OH 44102
PH: 1-800-969-3334

Or Fax this form to **1-216-251-7778**

Dustless Drywall Sanders

June 3, 1994

Niosh
4676 Columbia Pkwy
Cincinnati, OH 45226

Attention. Ken Mead

Thank you for your interest in the DDM DUSTLESS DRYWALL SANDER. I am pleased to tell you a little more about this remarkable machine

Basically, it consists of a specialized sanding head attached to a Clarke Industrial Vacuum by a 30 foot hose The supplementary footage of the hose creates easy access to essentially any job A 2-4 foot extension pole is included in the package The sturdy, yet compact pole adjusts to accommodate virtually any dimension of your wall or ceiling work

The rough surface or joint compound is cut loose from the wall by the custom cut DDM screenback sanding paper The dust is then drawn through the screenback and sanding block, down the hose and filtered by the Clarke Vacuum system

This unique setup has been successfully used by contractors for approximately ten years It will allow you to do sanding next to computers, over vegetable counters in grocery stores, in hospitals and numerous other dust sensitive areas The DDM DUSTLESS DRYWALL SANDER is a must for any contractor doing remodel work or one desiring standard drywall finishing without the irritation of the infiltrating dust

We here at DDM offer two different models of DUSTLESS DRYWALL SANDERS as indicated in our brochure, plus a DDM Kit The Clarke vacuums vary only in tank holding capacity and horse power of the motor, both packages include the accessories needed for dustless drywall sanding The kit only consists of a 30 foot hose, the patented sanding head and dimensioned extension pole, your own vacuum is used

A price list is enclosed I am sure the time you save in cleanup and the customers you will acquire with dust free drywall finishing will be well worth the money

If I can be of any help to answer questions or ship you one of our units, please feel free to contact me.

Sincerely,

DDM CORPORATION

Shirley A. Mehrer
sab

Shirley A Mehrer
President

SAM sab
Enclosures

DDM CORPORATION 2657 20th Ave West Seattle, WA 98199 (206) 282-3422

1994
DDM CORPORATION
PRICE LIST

DUSTLESS DRYWALL SANDER

DDM KIT. $467.00

DDM 600. . . . . $1,186.00

DDM 900. . . . . $1,812.00

DDM SCREENBACK

80 Grit. $126.10

100 Grit $120.73

180 Grit $94.82

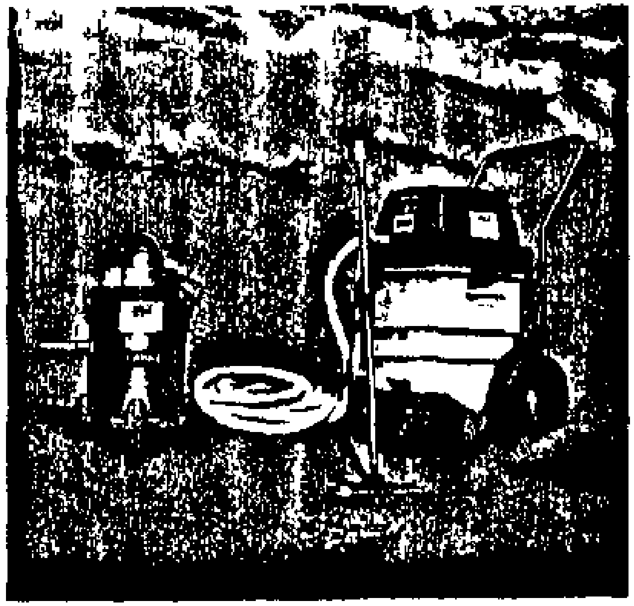
220 Grit $94.82

Above Screenback prices are per sleeve (100 pieces).
Prices F.O.B. Seattle, WA

DDM 600. A powerful yet lightweight model with a stainless steel tank that you can usually carry in a car trunk. It's mounted on four 2½" rubber ball-bearing swivel casters. A vinyl bumper around the base of the machine guards against damage to walls and furniture. Comes complete with 2-4' extension handle, 30' of hose, and the patented DDM sanding head.

DDM 900. A heavy-duty model with a tank made of POLYDUR, a high-density polyethylene that won't crack, break or dent, withstands most corrosives and comes with a no-time limit guarantee. It's mounted on a carriage with two 12" and two " wheels and a handle, an arrangement that allows for tilt-and-pour emptying. Comes complete with 2-4' extension handle, 30' of hose, and the patented DDM sanding head.

DDM Accessory Kit. For those who already own a satisfactory wet/dry vac, it consists of the extension handle, 30' hose and sanding head only.



DDM Dustless Drywall Sander Specifications

The DDM Dustless Drywall Sander comes in two versions, both utilizing industrial-grade wet/dry vacuums by Clarke for fast, thorough, *quiet operation*. Also available is an accessory kit for converting your existing wet/dry vac for dustless drywall sanding.

	DDM 600	DDM 900
Vacuum Model	Clarke 600-A	Clarke TMD-50
Motors	One 1 H P	Two 1 H P
Current	6 Amps	12 Amps
Motor Warranty	1 Year	3 Years
Air Movement	72 CFM	98 CFM
Water Lift	80"	151"
Filter Area	5 7 Sq Ft	10 Sq Ft
Tank Size	6 Gallon	13 2 Gallon
Power Cable	35	35
Weight	26 Lbs	81 Lbs

DDM CORPORATION

2657 20th West Seattle, WA 98199

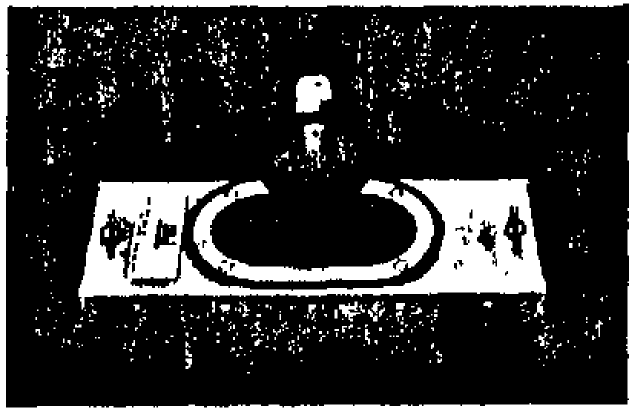
Leaving The Dusty Trail.

The DDM Dustless Drywall Sander smoothes rough surfaces while simultaneously vacuuming up the excess particles Its basic components are a specially designed sanding head and a commercial wet/dry vacuum. This tool does away with clouds of dust and white footprints tracking across expensive carpeting And many other irritations

Cleanliness Is Next To Profitableness.

The Dustless Drywall Sander cuts down on expensive clean-up time while increasing your potential for landing new jobs Many hospitals, for example, require dustless sanding equipment for any sort of work. It's also essential in computer rooms, laboratories, food preparation areas, and other environments that demand cleanliness In stores, offices or any sort of commerical establishment, this equipment will be appreciated because while you do your work, the owner can still do his.

must for doing just about any sort of remodel work It provides you with more customers and happier customers. And you know how profitable that can be



A Head So Smart, We Patented It.

The vacuum head of the DDM Dustless Drywall Sander is a one-piece aluminum casting mounted to a swivel that allows it to work at any angle A rigid backing plate with holes for applying vacuum accomodates screenback sandpaper of any grit

The result is a lightweight vacuum system that sits at the end of an extension pole

The Dustless Drywall Sander comes with a 2-4 foot extension pole The vacuum is applied through the handle, making this system as lightweight and uncumbersome as possible. The flexible hose connection to the wet/dry vacuum is a whopping 30 feet for easy access to any job.

The long handle and vacuum hose reduce the need for time-consuming ladders and scaffolding

Now, Everyone In The Drywall Business Will Breathe Easier.

Do away with dust masks and eye irritation Abraded fingers and tired elbows Cumbersome support systems. Time-consuming clean-up And customers irate over clouds and layers of dust or time lost to their business.

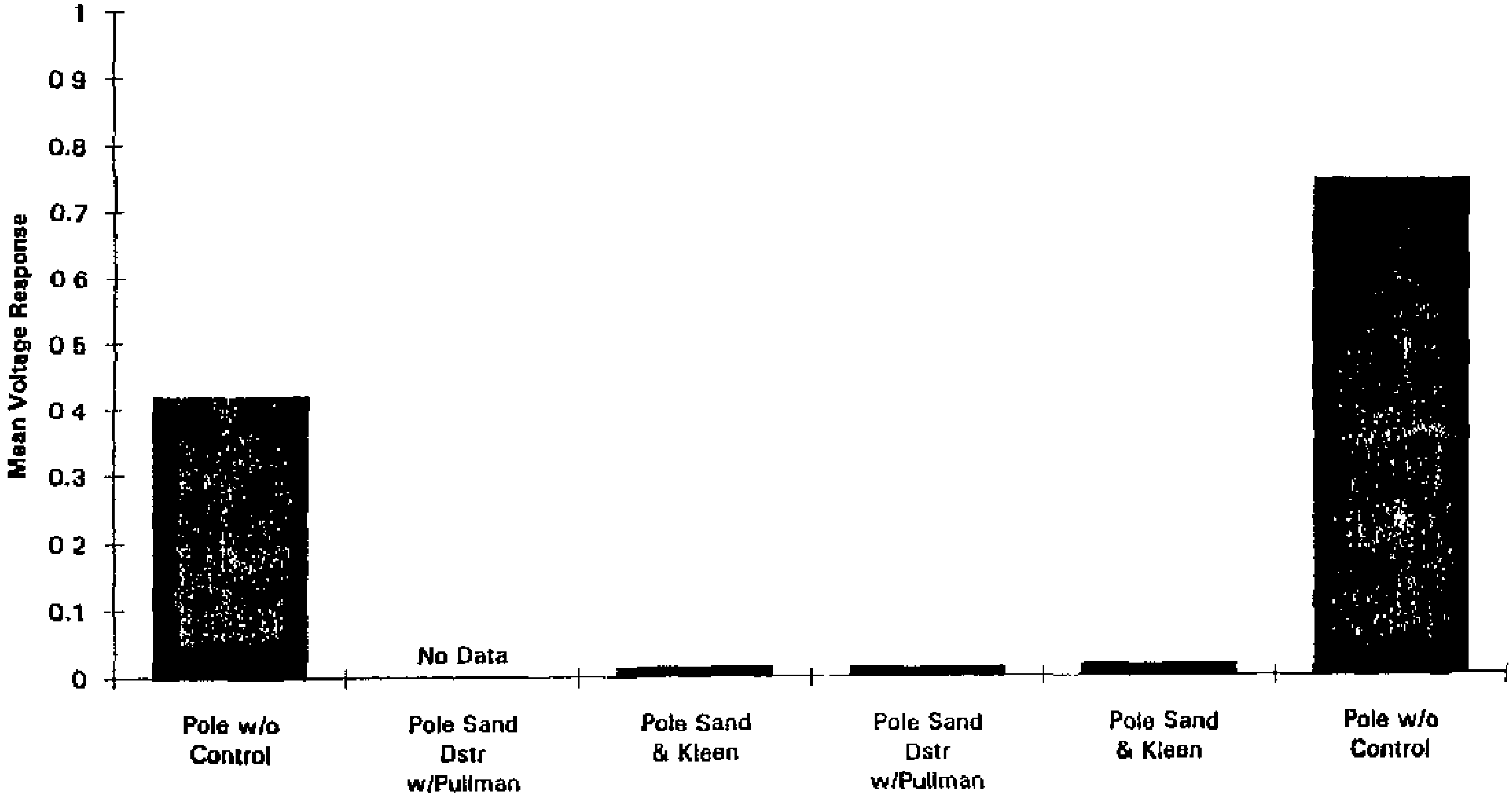
Get the DDM Dustless Drywall Sander, and eliminate many of your drywall sanding problems

APPENDIX D Real-Time Data

Appendix D contains a summary of data from each of the test runs as well as graphs depicting the mean voltage value for each test run displayed according to the test block in which the run occurred

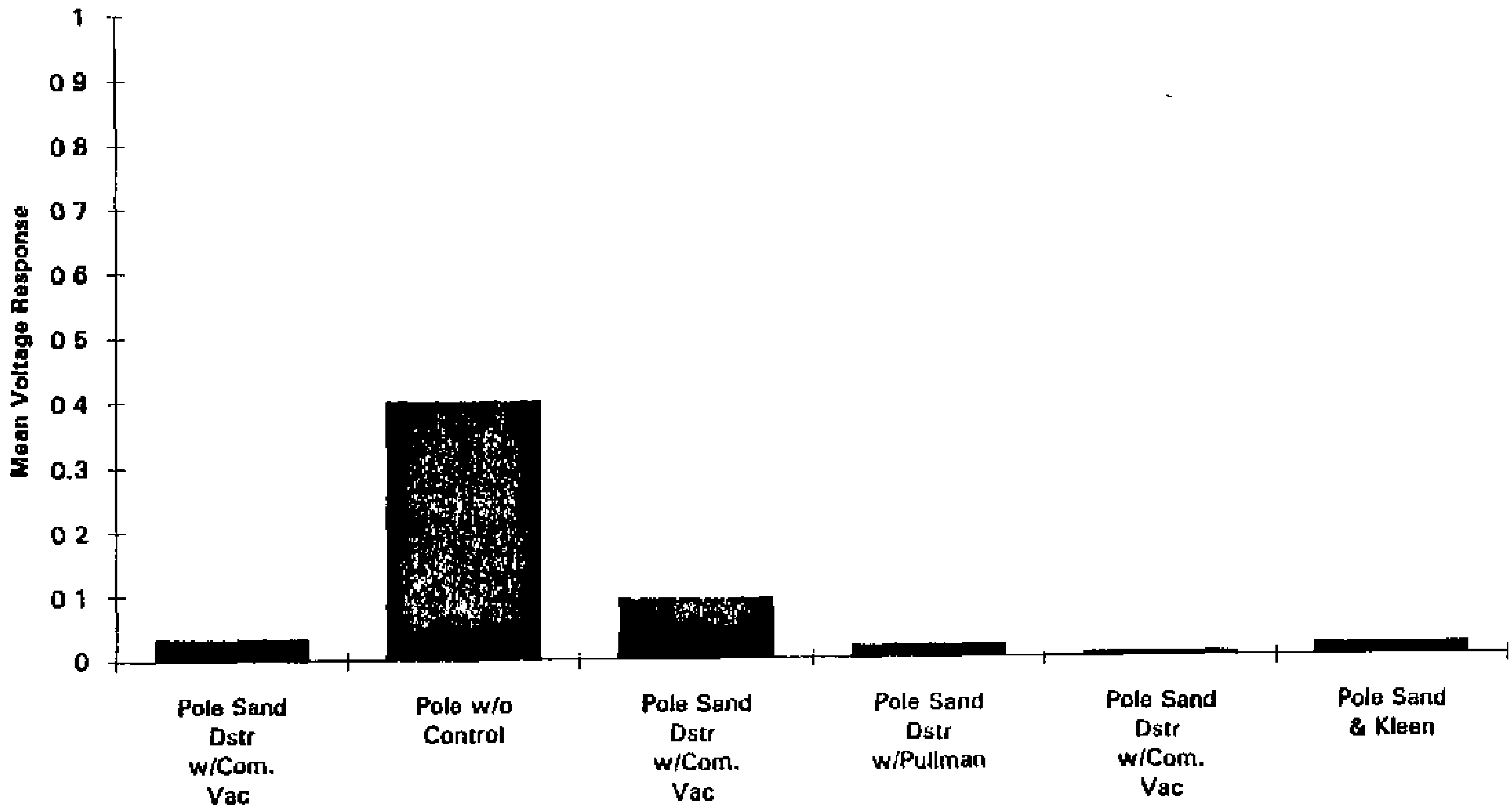
SEATTLE AREA APPRENTICESHIP TRAINING CENTER					
DRYWALL CONTROLS COMPARISON SURVEY					
		26-28 April 1994			
TEST RUN DESCRIPTION	DATE	DELTA (T) SECS	SUM VOLTAGE	MEAN	COMMENTS
Pole 2 1 1 E Pole w/o Control	4/25 PM	1222	515 706	0 42202	
Pole 2 1 2 F Pole Sand Dstr w/Pullman	4/25-PM	No data	No data		Probs w/datalogger
Pole 2 1 3 B Pole Sand n-Clean	4/25 PM	1198	18 8368	0 01572	
Pole 2 1-4 C Pole Sand Dstr w/Pullman	4/25 PM	1645	25 2072	0 01532	
Pole 2 1 5 D Pole Sand n-Clean	4/25 PM	1211	22 8814	0 0189	
Pole 2 1 6 A Pole w/o Control	4/25-PM	1208	898 5288	0 74382	
Hand 1 1 1-B Hand Sand-n-Clean	4/26-AM	1195	26 4047	0 0221	
Hand 1 1 2-C Hand Fibatape	4/26 AM	1195	29 8828	0 02501	
Hand 1 1 3 A Hand Sand n-Clean	4/26-AM	1188	30 7694	0 02589	
Hand 1 1-4-D Hand w/o Control	4/26-AM	1213	1370 9185	1 13019	
Hand 1 1 5 E Hand FibaTape	4/26 AM	1199	47 381	0 03952	
Hand 1 1 6 F Pole w/o Control	4/26-AM	1218	645 7576	0 53018	
Pole 2 2 1 B Pole Sand Dstr w/Com	4/26 PM	1201	41 5677	0 03461	
Pole 2 2 2 C Pole w/o Control	4/26 PM	1195	480 5435	0 40213	
Pole 2 2 3 A Pole Sand Dstr w/Comm Vac	4/26 PM	1184	151 0228	0 12755	incl 30s of bad data
Pole 2 2 3 A Pole Sand Dstr w/Comm Vac (opt)	4/26 PM	1153	112 0007	0 09714	30s bad data not incl
Pole 2 2-4 D Pole Sand Dstr w/Pullman	4/26 PM	1194	25 02	0 02095	
Pole 2 2 5 E Pole Sand Dstr w/Comm Vac	4/26 PM	1216	8 7712	0 00721	
Pole 2 2 6 F Pole Sand-n Clean	4/26 PM	1206	22 8566	0 01895	
Hand 1 2 1 C Hand w/o Control	4/27 AM	Bad Data	Bad Data		HAM Disconnected
Hand 1 2 2 D Pole w/o Control	4/27 AM	1189	854 1061	0 71834	
Hand 1 2 3 B Pole w/o Control	4/27 AM	1236	278 0066	0 22492	
Hand 1 2 4 F Hand Sand n-Clean	4/27 AM	1205	49 5035	0 04108	incl 24s breaker pause
Hand 1 2 4 F Hand Sand n Clean (optional)	4/27 AM	1181	48 9872	0 04148	breaker pause subtracted
Hand 1 2 5 E Hand w/o Control	4/27-AM	1295	968 6789	0 74801	
Hand 1 2 6 A Hand FibaTape	4/27-AM	1188	83 2354	0 07006	
Pole 1 1 1 C Pole Sand Dstr w/Pullman	4/27-PM	1209	27 6808	0 0229	
Pole 1 1 2 D Pole Sand n Clean	4/27 PM	1205	33 7261	0 02796	incls 21s breaker pause
Pole 1 1 2 D Pole Sand n Clean (opt)	4/27-PM	1185	33 0399	0 02788	breaker pause subtracted
Pole 1 1 3 B Pole Sand Dstr w/Pullman	4/27 PM	1195	33 2915	0 02786	
Pole 1 1 4 F Pole Sand Dstr w/Comm Vac	4/27 PM	1205	90 5525	0 07515	
Pole 1 1 5 E Pole Sand n Clean	4/27 PM	1195	49 1153	0 0411	
Pole 1 1-6 A Pole Sand Dstr w/Comm Vac	4/27 PM	1204	44 2907	0 03679	
Pole 1 2 1 D Pole w/o Control	4/28 AM	1234	657 5285	0 53284	
Pole 1 2 2 E Pole Sand Dstr w/Pullman	4/28 AM	1192	27 1646	0 02281	
Pole 1 2 3 F Pole w/o Control	4/28 AM	1234	655 1487	0 53091	
Pole 1 2 4 B Pole Sand Duster w/Comm Vac	4/28 AM	1209	45 3064	0 03747	
Pole 1 2 5 A Pole Sand n Clean	4/28 AM	1194	24 2000	0 02027	
Pole 1 2 6 C Pole w/o Control	4/28 AM	1204	417 0732	0 34641	
Add On Run DDM Pole Sander w/Clark Vacumn	4/28 PM	726	12 4105	0 01709	
H 2 1 1 D Pole w/o Control	4/28 PM	320	245 319	0 76662	
H 2 1 2 F Hand Sand n Clean	4/28 PM	323	18 9659	0 05872	
H 2 1 3 A Hand FibaTape	4/28 PM	283	10 6169	0 03752	
H 2 1 4 C Hand Sand n Clean	4/28 PM	311	12 3957	0 03986	
H 2 1 5 E Hand FibaTape	4/28 PM	192	7 0806	0 03688	
H 2 1 6 B Hand w/o Control	4/28 PM	275	215 6444	0 78416	

Pole Block 1A



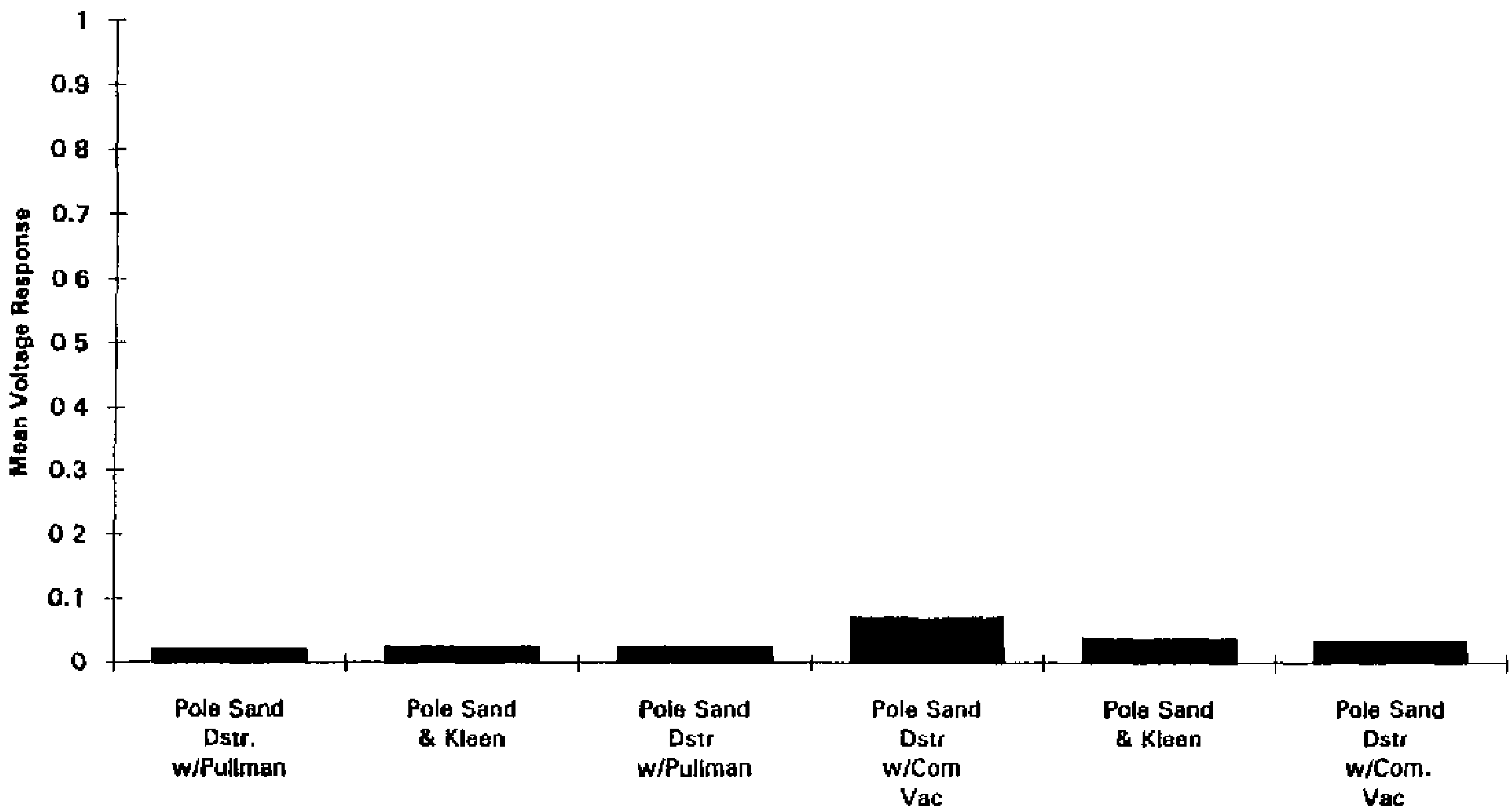
D2

Pole Block 1B

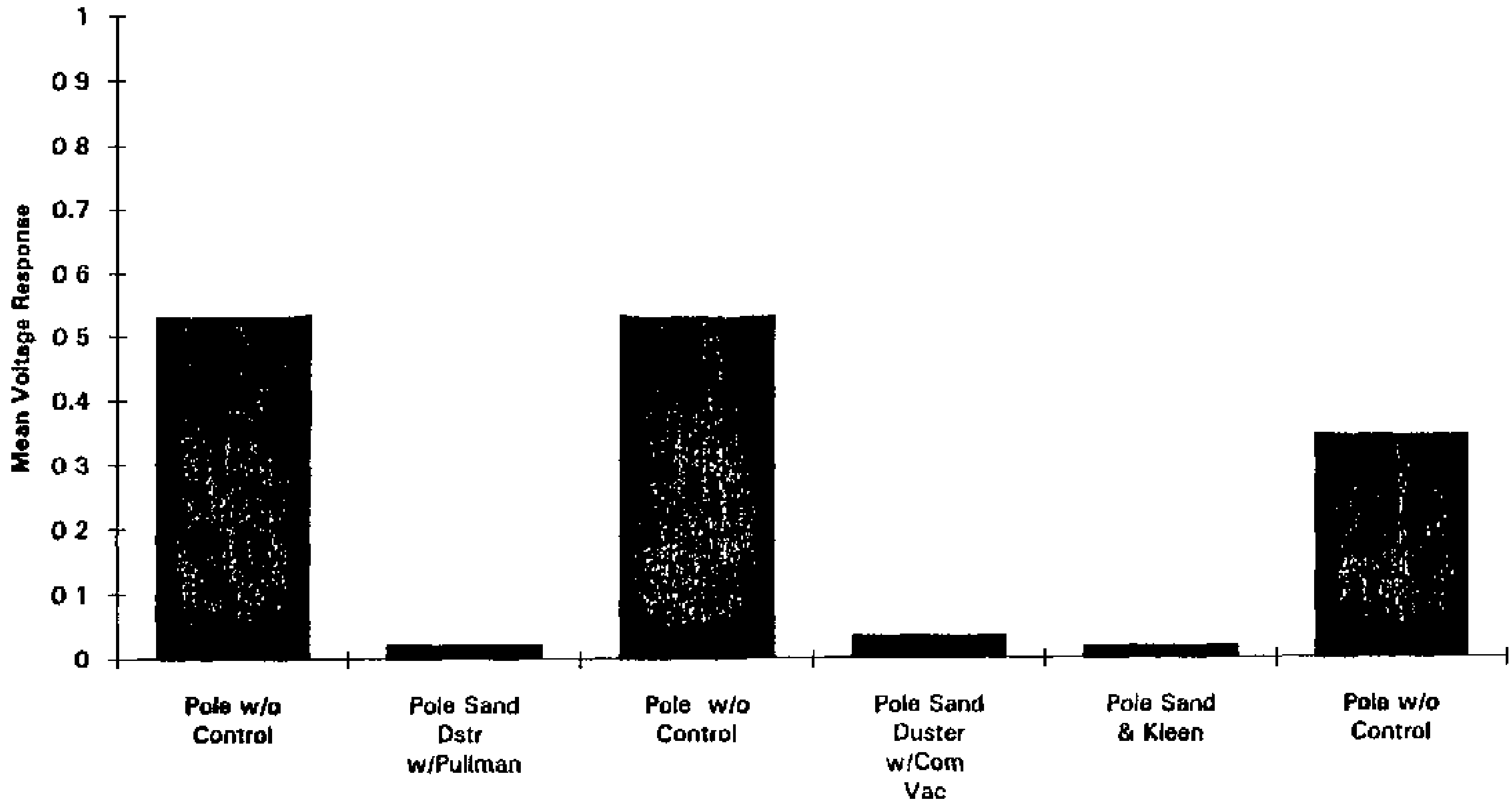


D3

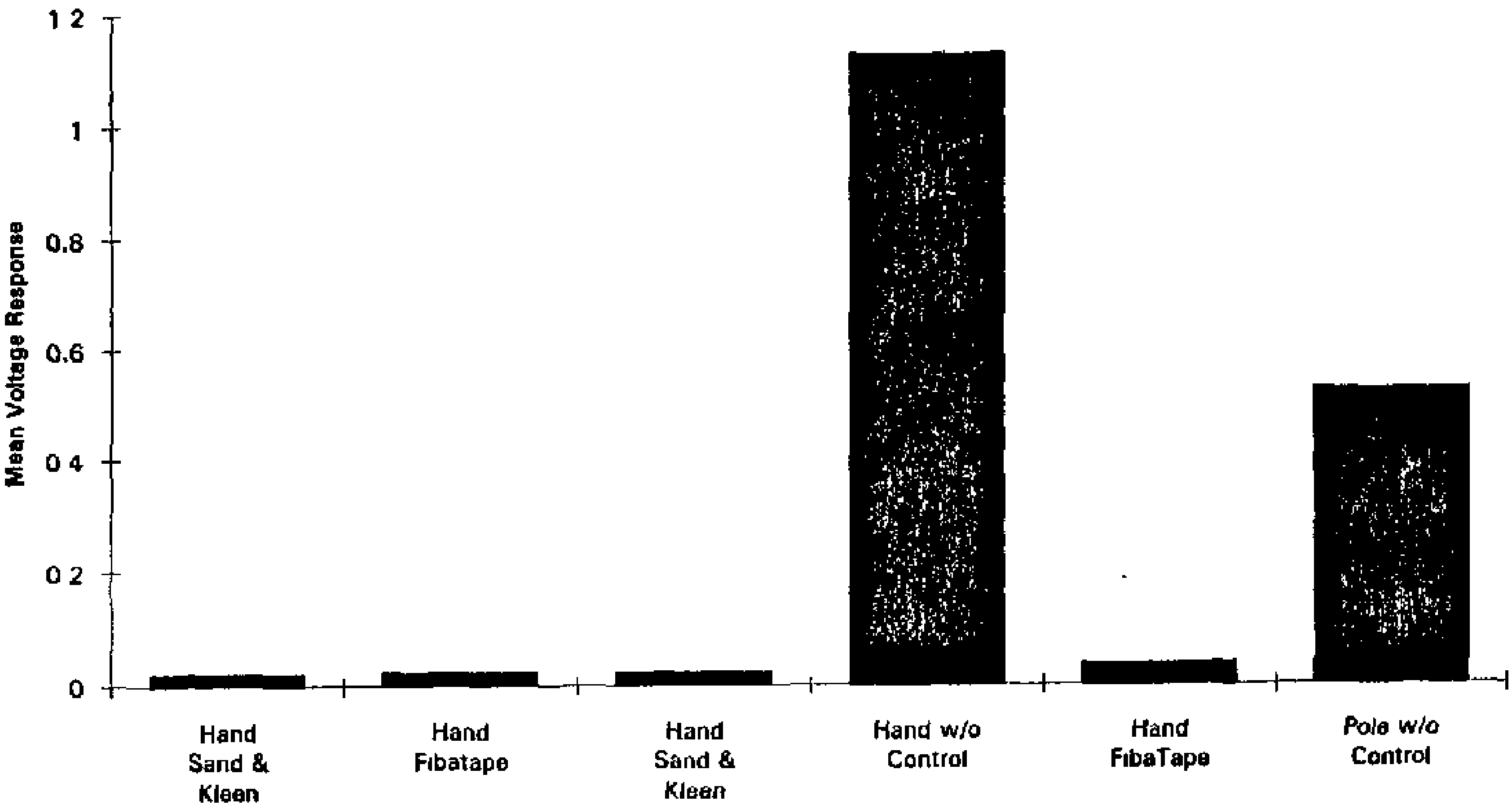
Pole Block 2A



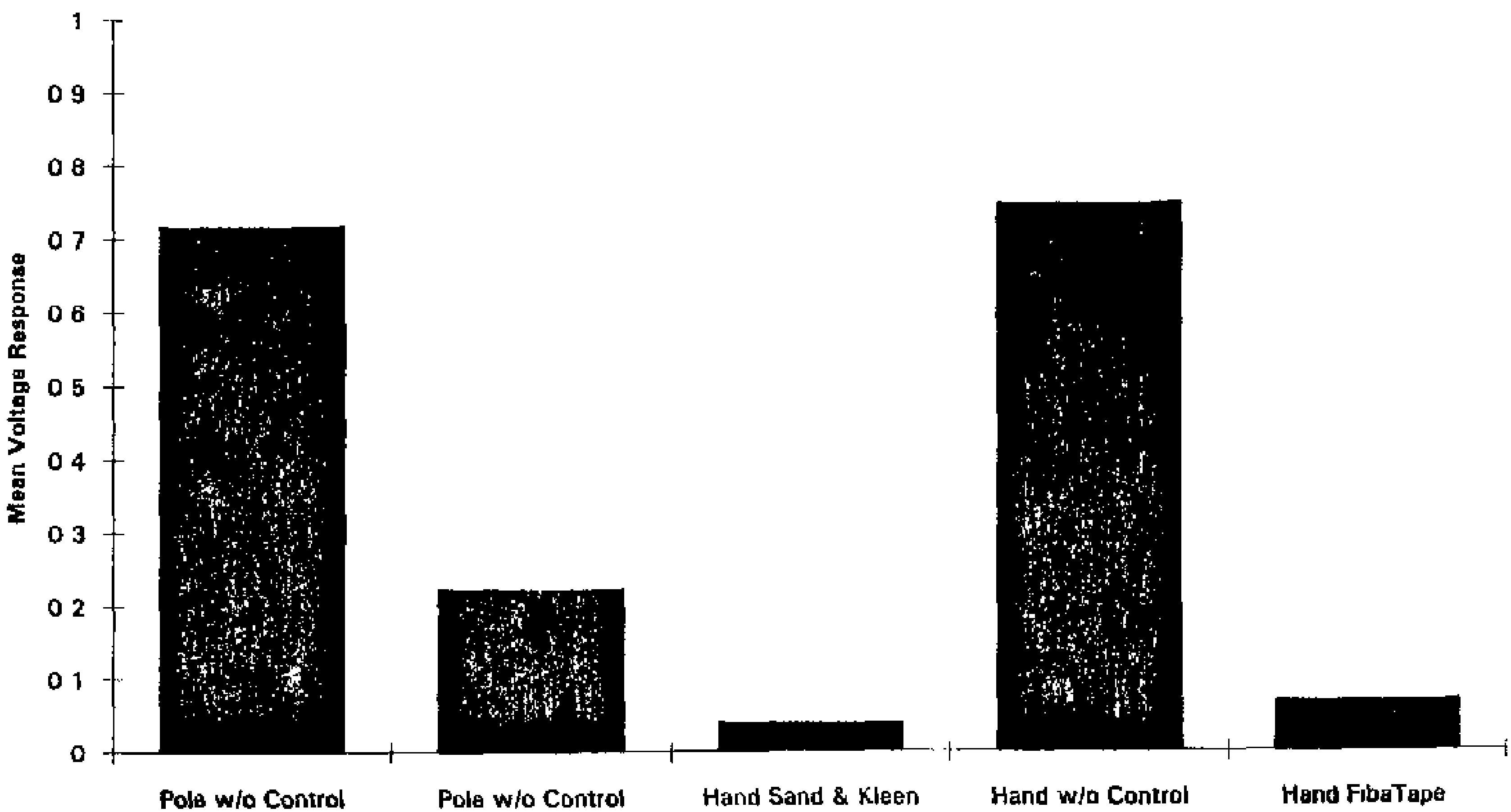
Pole Block 2B



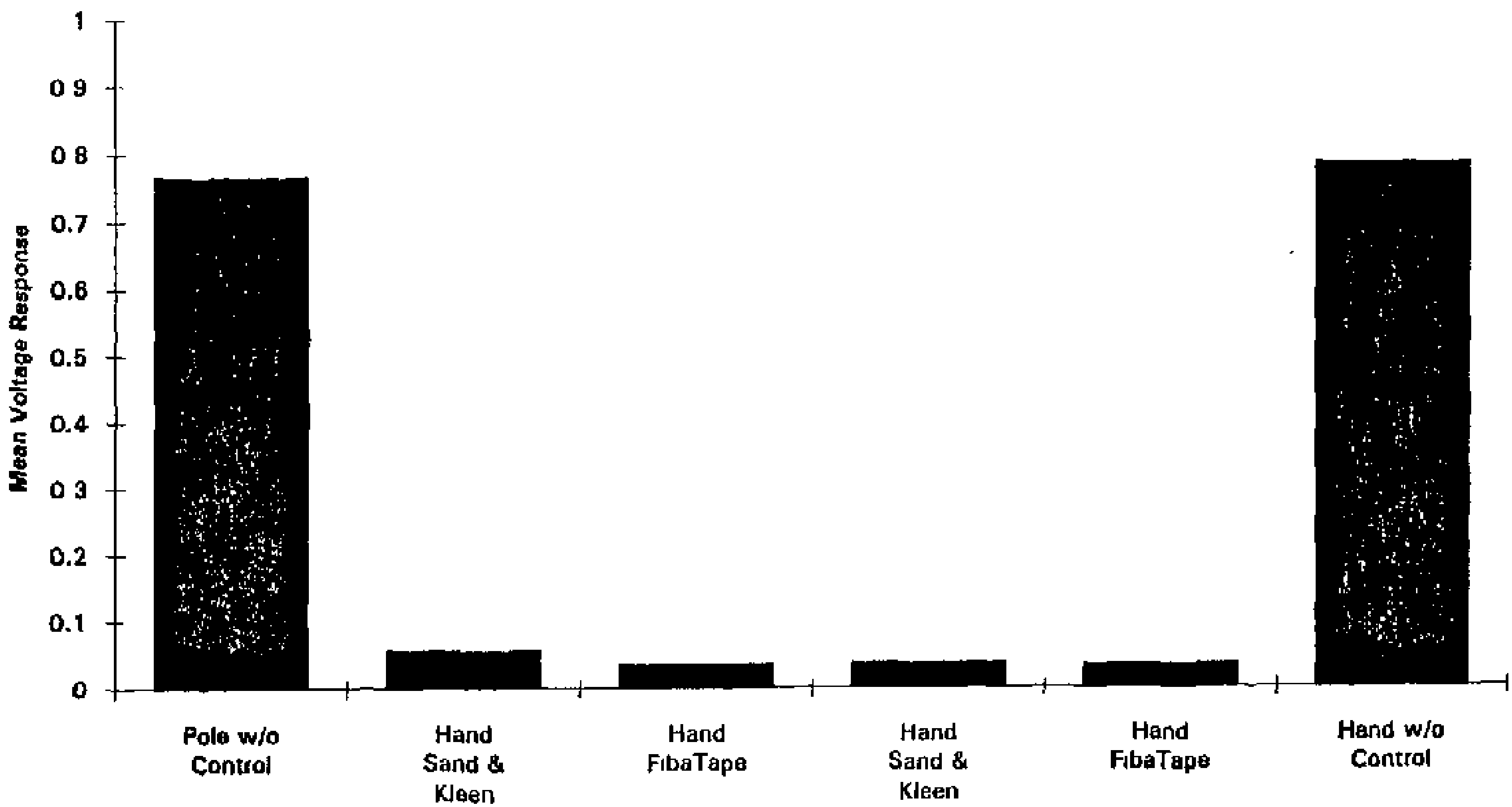
Hand Block 1A



Hand Block 1B



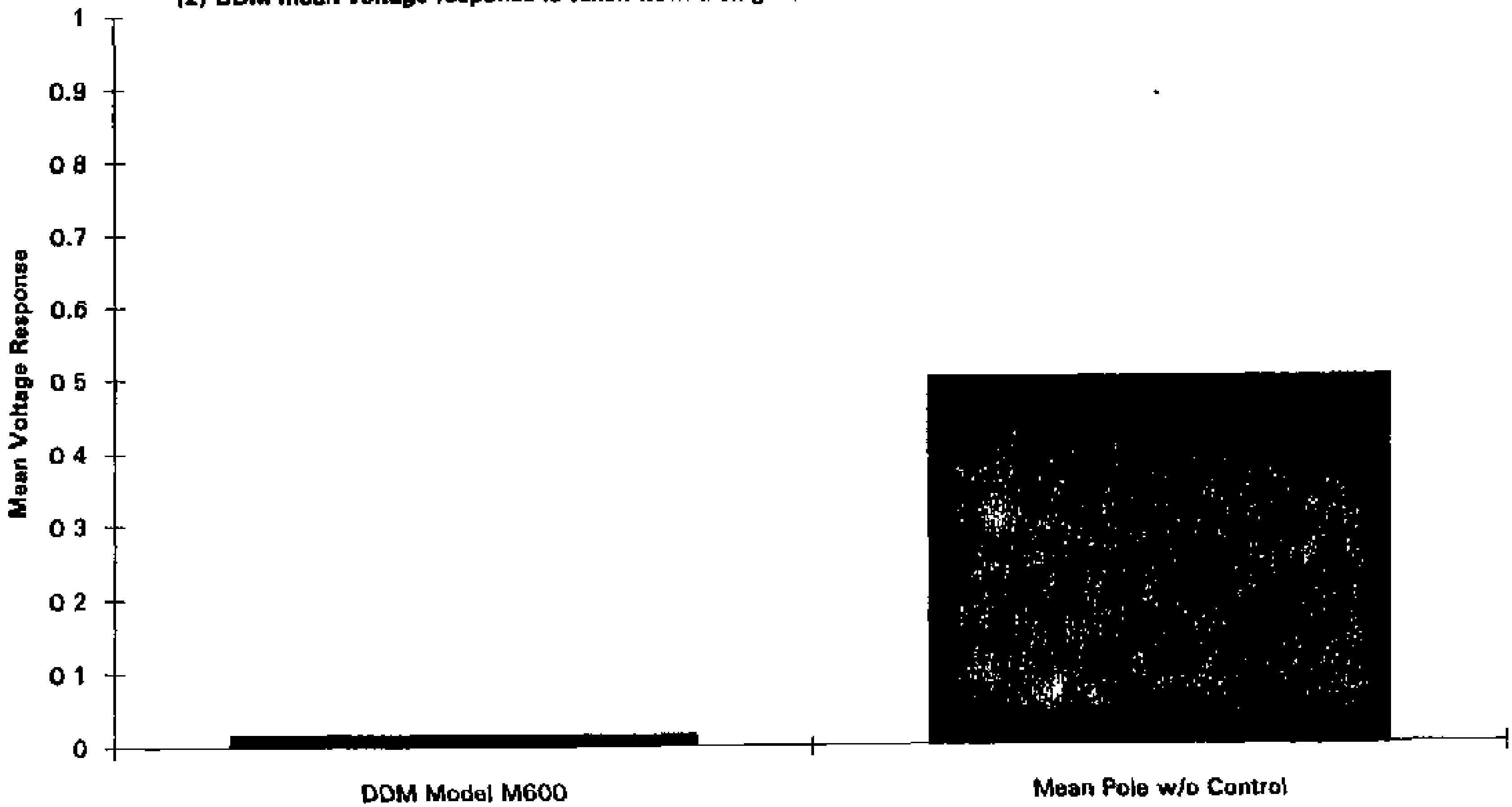
Hand Block 2A



DDM vs Mean Pole w/o Control

(1) Mean Pole w/o Control = sum of all voltage responses/total sample time all runs in catagory

(2) DDM mean voltage response is taken from a single test run



APPENDIX E STATISTICAL ANALYSIS

The statistical analysis report is presented in two sections Section 1 is an analysis of the Pole Sanding Category Results and Section 2 is an analysis of the Hand Sanding Category results

To Kenneth Mead
From Thomas Fischbach
Subject Report on Statistical Analysis Pole Sanding Controls for Dust

Study Description, Design and Objectives

Four pole sanding devices with different dust control mechanisms (controls) were studied These are designated as without control, Sand Duster with a Commercial Vacuum, Sand & Kleen, and Sand Duster with Pullman Vacuum The study was conducted by randomly assigning a control to sand one of six nearly identical rooms that had been recently plastered and allowed to dry During the sanding the amount of dust generated in the room was measured by an area sampler that produced a voltage response each second The voltage response is directly proportional to the concentration of dust in the room in that one second interval. Personal breathing zone dust levels for the operator of the controls during the sanding were also measured in about half of the sanding episodes An equipment malfunction prevented personal breathing zone measurement in the remaining cases The objectives of the study addressed by the statistical analysis are 1) to determine if there are any differences among the four controls in the dust levels produced when each is used for plaster sanding and, if so, which of the controls differ from each other and by how much, 2) to provide an evaluation of the performance of the DDM Model 600 (for which there is only one observation) relative to the other four pole sanding devices, and 3) to examine the relation between measured personal breathing zone dust concentration and average per second voltage.

One random assignment of the four controls to the six rooms is termed a Block Because there were more rooms than controls, some controls were assigned to more than one room, but each control was assigned to at least one room in every block However, the block assignments were done in pairs, termed Setups, so that three rooms were assigned to each control in the two blocks of every Setup The plan called for assigning two rooms to three controls (selected at random) and one room for the remaining control in the first Block in a Setup In the second Block, the controls that had been assigned to two rooms in the first block were assigned to one room, while the remaining control was assigned to three rooms [In retrospect, a better plan, i e , with better "balance," would have assigned two rooms to each of two controls and one room to each of the remaining two controls for the first Block with a reversal of this arrangement in the second block] Aside from the number of rooms assigned to each control, the specific room assignments were always randomly determined

The six rooms were designed to be as similar as possible and were plastered in the same manner Two blocks could be run in one day in the morning and in the afternoon This required a plastering and an adequate delay for drying after the first block had been run Since the plaster had dried overnight before the morning block was done and the drying time for the afternoon runs was less, there could be differences associated with drying time These differences were confounded with Setups but not Blocks within Setups by planning to run both Blocks in the same Setup either in the morning or the afternoon Thus, the effect of drying time was not confounded with control

It was only possible to run two complete Setups Hence, there was some confounding of Block differences and control differences

Three specific runs had questionable data in whole or part. In two cases there was an equipment malfunction for 21 (for the Sand & Kleen Control) and 30 (for the Sand Duster with Commercial Vacuum) seconds, respectively In one case (for the Sand Duster with Commercial Vacuum), the investigator remarked that the data produced was "suspicious "

Analysis

1. Data Preparation

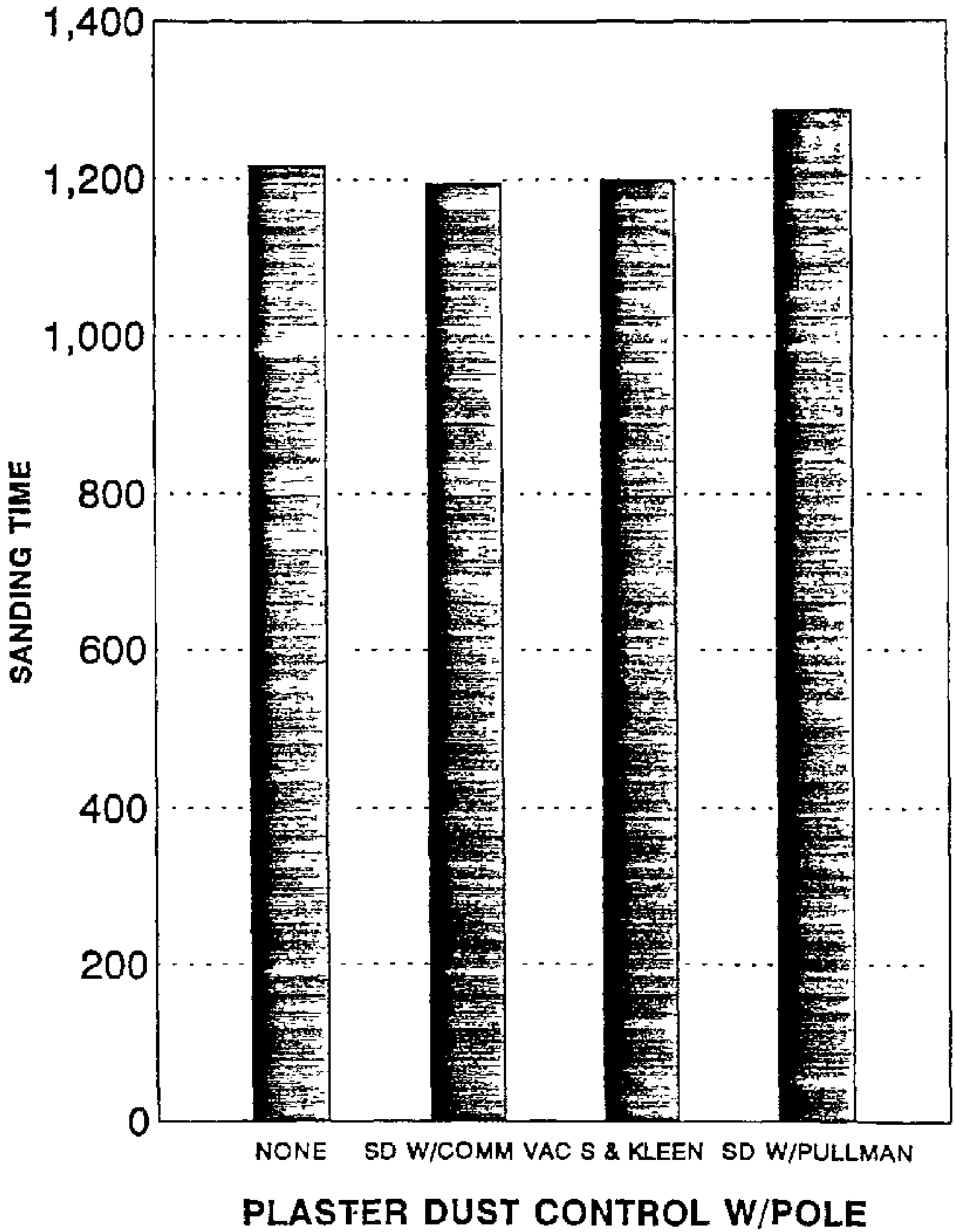
Because the study was performed in non-government facilities, only two SETUPs (four BLOCKS) could be run This produced 24 runs over four days Three blocks were run in the morning while one was run in the afternoon

Eight datasets were prepared depending on the treatment for the three runs with questionable data These eight datasets represent all possible combinations of including or excluding the questionable data for those three runs For example, the first data set -- using only the "best" data -- excluded the responses for the 21 and 30 seconds, respectively, of the two runs with equipment malfunctions and excluded all the data for the run described as questionable Dataset 8 included the responses during equipment malfunction for the two runs with this problem and the "suspicious" data The other six dataset were formed by all combinations of including one or two of the problem runs

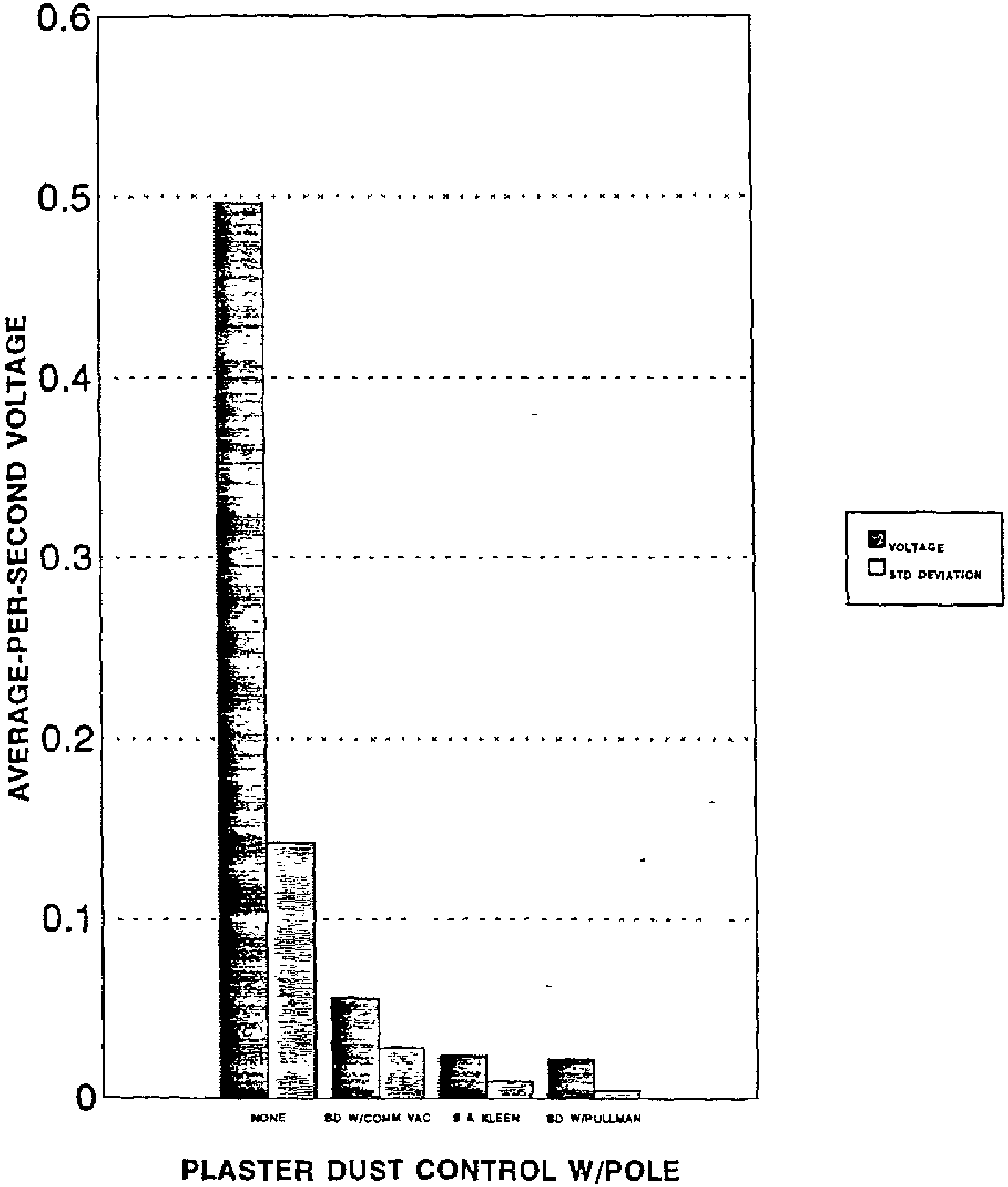
The voltage responses of the area dust sampler were used without conversion into a concentration measurement because the latter would be a linear transformation of the former and the results of the main statistical analyses are invariant to linear transformations The responses for the one second intervals were added for the total duration of the sanding The duration of sanding varied from run to run The differences among the controls, Setups, Blocks, and Rooms in the mean total seconds required for sanding were not remarkable (see Figure 1) Moreover, the voltage total of a run was not found to be related to the number of seconds sanding required for that run ($p < 0\ 83$) Nevertheless, to correct for differences in time required for sanding, the total voltage for a run was divided by the total seconds required for sanding to produce the response variable for the analysis, the average voltage per second

A preliminary analysis revealed that both the standard deviations of the total voltage and average voltage per second were, respectively, proportional to the means of the same responses (see Figure 2) Thus, the natural logarithm of average voltage per second was used as response variable for the analysis

TIME REQUIRED FOR SANDING BY CONTROL



MEAN AND STANDARD DEVIATION OF VOLTAGE BY CONTROL



2 Analysis Results

While we originally intended to analyze all eight datasets to determine if and to what extent conclusions varied with the inclusion or exclusion of the problem data, only the first dataset (the "best" data) and dataset 8 (the "worst" data) were analyzed There was no difference in the conclusions to be described below Only the results for dataset 1 are reported

The factors that were considered in the analyses were time required to complete sanding (TIME), SETUP, block within SETUP (BLOCK(SETUP)), room sanded (ROOM), and CONTROL The effects of sequence of the run within a block (SEQ) and the day (DAY) of the run were also examined in a separate analyses In addition, the effects associated with the interactions of CONTROL with SETUP and BLOCK(SETUP), respectively, were also analyzed as components of the error term for the evaluation of the statistical significance of CONTROL differences

Initial analyses found little evidence of real effects associated with time required for sanding ($p < 0\ 60$) regardless of whether the analysis was on the log-transformed scale or the original scale or what other factors were included in the same fitted model We speculated that as the sanding progressed from one room to another there was the potential for dust build-up However, the analysis of possible effects associated with the sequence of the run within a block produced little evidence to support that speculation ($p < 0\ 67$) regardless of the scale of the response variable The differences among the four days during which sanding with a pole was done were also not close to statistical significance ($p < 0\ 25$) regardless of the scale of the response variable Because all but one of the pole sanding blocks were run in the afternoon, no meaningful analysis of the effect of time of day was feasible Thus, the factors of TIME, SEQ, DAY, and time of day were ignored in the main analyses

The analyses began with a full model including SETUP, BLOCK(SETUP), ROOM, CONTROL, CONTROL x SETUP, and CONTROL x BLOCK(SETUP), i e , the most conservative model for detecting differences among the controls A series of analyses led to what appeared to be the most plausible model that included only CONTROL Both fixed effect and mixed model (with SETUP, BLOCK(SETUP), the interaction terms as random effects) based analyses were performed The results, on either scale for the response, for all effects other than those for CONTROL can be summarized as follows

SETUP - There was no prior reason to expect that this factor was important It never approached statistical significance in any analysis whether treated as a fixed or a random effect

BLOCK(SETUP) - The design introduced partial confounding between BLOCK and CONTROL Other than this there was no prior reason to expect that this factor was important This factor was statistically significant if entered in the model before CONTROL but never for the reverse order On the other hand, CONTROL was statistically significant for either case We concluded that the statistical significance of BLOCK(SETUP) was the result of the confounding

ROOM - Because the rooms were designed to be similar, there was no prior reason to expect differences in dust concentration among the six rooms However, because of both the design and the limited number of SETUPS which could be run, the effects of CONTROL and ROOM were partially confounded in the data ROOM was statistically significant if entered in the model before CONTROL but never in the reverse case, while CONTROL was highly significant in either order except in one case when the response was analyzed on its original scale. This case occurred for the most conservative test under the mixed effects model when the expected values of the various mean squares were used to find a function to estimate the appropriate error term We concluded that the cases of statistical significance of ROOM were the result of confounding with CONTROL effects

SETUP x CONTROL
BLOCK(SETUP) x CONTROL - These factors were important as possible error terms or denominator factors for testing the hypothesis of no CONTROL differences Neither ever approached statistical significance whether treated as a fixed effects or a random effects In the latter case, the appropriate denominator terms were determined from the expectations of the mean squares We concluded that the constraints of the blocking in the design did not produce intra-block correlations among the runs within a block or setup of any important magnitude

The basic conclusion that there were substantial differences among the controls did not depend on how the analysis was done (the range of p-values was 0 02 for the mixed-model-based analysis to 0 0001 when CONTROL is the only factor in the model) Moreover, in all cases the Scheffe' multiple comparison analysis finds that the "w/o control" resulted in significantly greater dust concentrations than any other control The most conservative estimator of the error term for the CONTROL mean square had only 1 55 degrees of freedom (as estimated using Satterthwaite's method), which results in low statistical power for detecting differences among controls (the F-ratio required to find a difference significant at the 0 05 level is 37.48). Using that conservative estimator, the three pole sanders with a control were not found to differ However, in every other analysis the Sand Duster with a Commercial Vacuum Cleaner was found to have a significantly higher average per second voltage (or dust concentration) than the Sand & Kleen or the Sand Duster with Pullman Vacuum Cleaner The difference between the latter two controls was not statistically significant in even the analysis with the greatest statistical power However, the differences among the three pole dusters with controls were an order of magnitude smaller than those between the Sand Duster with a Commercial Vacuum Cleaner and the pole sander without a control

The foregoing results are summarized in Tables 1 and 2 and Figures 3 and 4, all based on the final model with greatest power

Table 1 shows estimates of the average per second voltage for each sanding device Both a single "best," the mean, and the limits for a confidence estimate are shown The confidence intervals for the four devices have a joint or simultaneous confidence of about 95% The estimates were constructed on the logarithmic scale and then transformed to the original scale The pole without a control was also studied in a second experiment on hand sanding The difference in the average-per-second voltage responses for the pole without control between the two experiments was not statistically significant Groups of devices not found to have significant statistical differences are also shown The single response for the DDM Model 600 is also shown and tentatively placed in the most plausible group

Figure 3 graphically displays the 95% confidence intervals and the single best estimates of average-per-second voltage

TABLE 1: AVERAGE PER SECOND VOLTAGE BY POLE SANDING DEVICE

CONTROL	N	QUASI-SIMULTANEOUS 95% CONFIDENCE INTERVALS OF AVERAGE PER SECOND VOLTAGE BY SANDING DEVICE[1]			DEVICES IN STATIS-TICALLY EQUAL[2] GROUPS	ESTIMATE OF THE STANDARD ERROR OF MEAN BY CONTROL[3]
		LOWER LIMIT	MEAN	UPPER LIMIT		
W/O Control[P]	6	0 302	0.486	0 781	│	0 0678
W/O Control[A]	9	0 313	0 493	0 776	│	0 0656
Sand Duster W/Comm Vacuum	5	0 031	0 052	0 087	│	0 0079
Sand & Kleen	6	0 014	0 023	0 037	│	0 0032
Sand Duster W/Pullman	5	0 013	0 022	0 037	│	0 0033
DDM Model 600[4]	1	N/A	0 017	N/A	│ ?	N/A

[P] Using data from the pole sanding experiment only.

[A] Using the average of both the pole and the hand sanding experiments. The difference in response in the two experiments was not statistically significant.

[1] Results for simultaneous 95% intervals constructed with the Scheffe' method on the logarithmic scale were transformed to the original scale. These do not include the DDM Model 600 observation The simultaneous 95% confidence applies to comparisons with either base separately but not to both simultaneously.

[2] "Equal" groups were not found to have statistically significant differences.

[3] Standard errors are proportional to the mean values

[4] A single observation subject to unknown error.

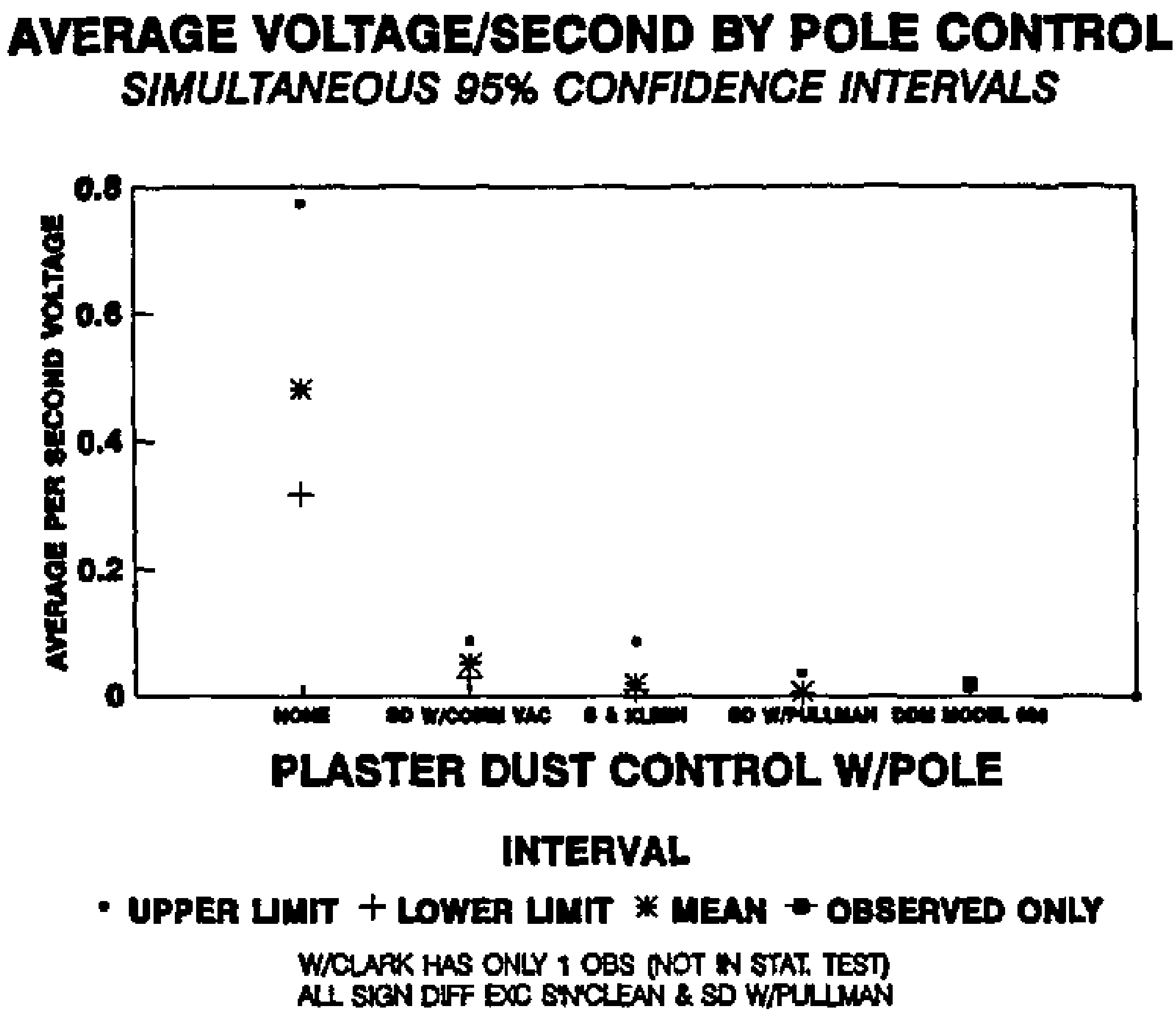


Figure 3 Average-per-second voltage by pole sanding device

Table 2 shows estimates of the ratios of the three devices with dust controls to the no control device, expressed as a percentage. Both a single "best" estimate, the mean, and the limits of a confidence interval estimate are shown. The interval estimates for the three devices with a control have a joint or simultaneous confidence of about 95% (since simultaneous 95% confidence intervals on the logarithmic scale were transformed to the original scale). Three sets of estimates appear for each estimate of the no control average-per-second voltage. Using the upper limits, there is 95% confidence that the minimum reductions in exposure are at least 91% with the Sand Duster w/Pullman and the Sand & Kleen and at least 79% with the Sand Duster w/Commercial Vacuum. The best single estimates are reductions of 95% each by the Sand Duster w/Pullman and the Sand & Kleen and 89% by the Sand Duster w/Commercial Vacuum. These results are graphically displayed in Figure 4.

TABLE 2: COMPARISON OF POLE SANDING WITH DUST CONTROLS TO POLE SANDING WITHOUT DUST CONTROL: PERCENTAGE OF DUST EXPOSURE

CONTROL	BASE OF COMPARISON	QUASI-SIMULTANEOUS 95% CONFIDENCE INTERVALS OF PERCENTAGE OF DUST EXPOSURE WITH CONTROL[1]			STANDARD ERROR OF MEAN[2]
		LOWER LIMIT	MEAN	UPPER LIMIT	
Sand Duster W/Pullman	W/O Control[P]	2.43%	4.58%	8.64%	0.954%
Sand & Kleen	W/O Control[P]	2.61%	4.78%	8.74%	0.947%
Sand Duster W/Comm Vacuum	W/O Control[P]	5.76%	10.85%	20.46%	2.259%
DDM Model 600[3]	W/O Control[P]	N/A	3.50%	N/A	N/A
Sand Duster W/Pullman	W/O CONTROL[A]	2.42%	4.51%	8.39%	0.919%
Sand & Kleen	W/O CONTROL[A]	2.60%	4.70%	8.49%	0.911%
Sand Duster W/Comm Vacuum	W/O CONTROL[A]	5.74%	10.68%	19.88%	2.177%
DDM Model 600[3]	W/O CONTROL[A]	N/A	3.45%	N/A	N/A

[P] Using data from the pole sanding experiment only

[A] Using the average of both the pole and the hand sanding experiments.

[1] Results for simultaneous 95% confidence intervals constructed with the Scheffe' method on the logarithmic scale were transformed to the original scale. These do not include the DDM Model 600 observation. The percent reduction is 100% minus the value in the table. The 95% confidence applies for one comparison base but not both simultaneously

[2] Standard errors are proportional to the mean values.

[3] A single observation subject to unknown error

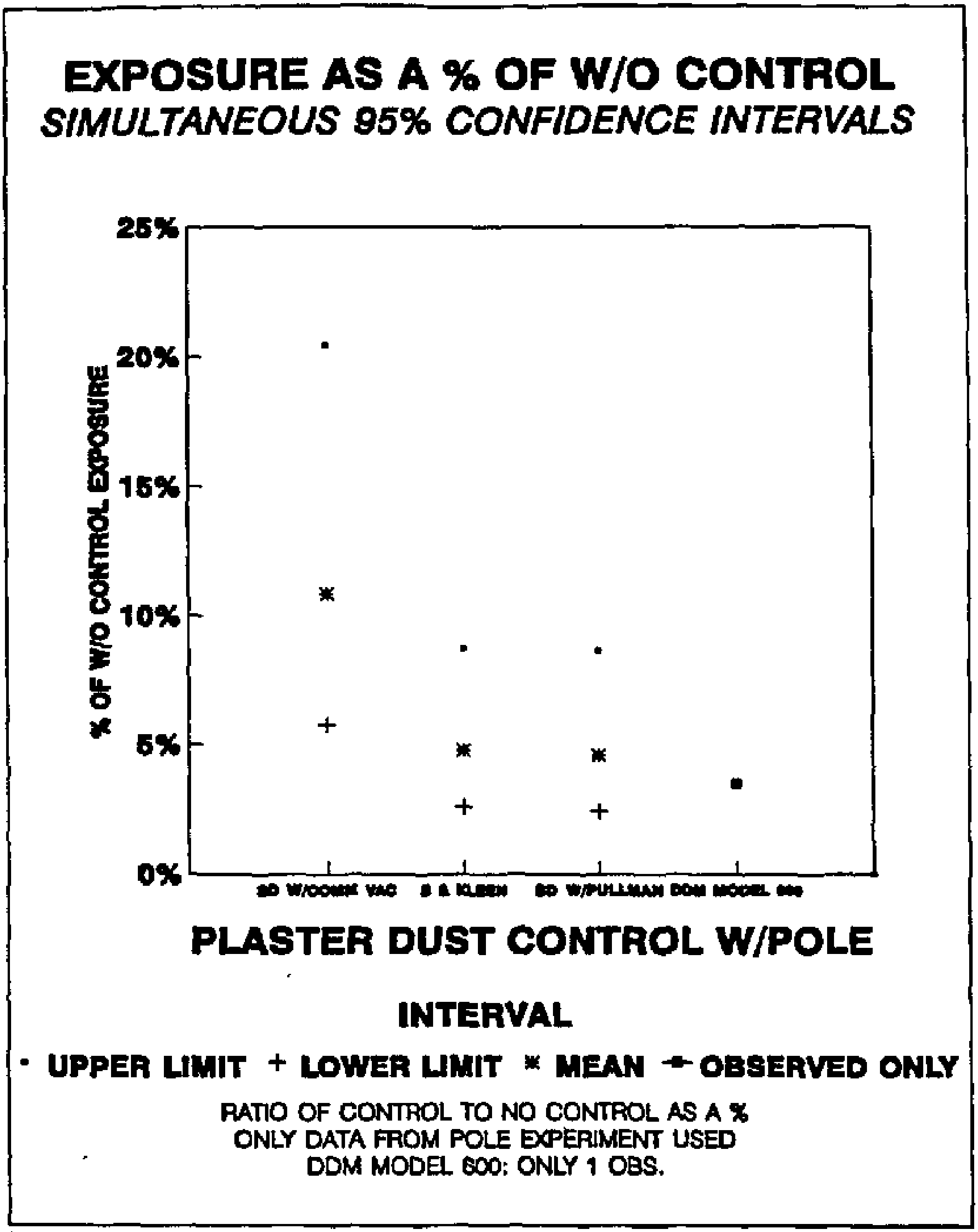


Figure 4 Exposure for pole sanding with a dust control as a percent of the exposure without a control

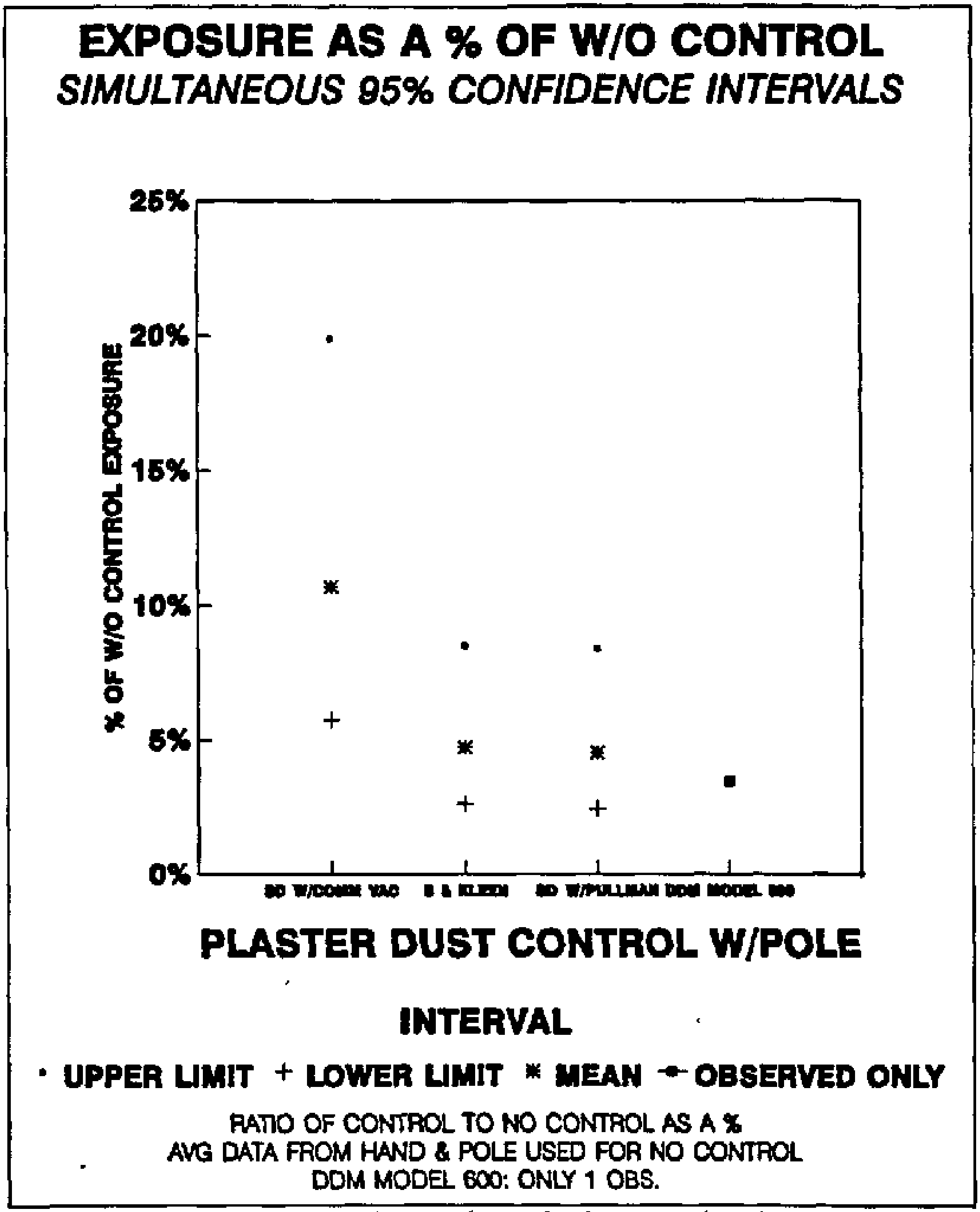


Figure 5 Exposure during sanding with a pole device with a dust control as a percent of exposure without a control the without control exposure estimate uses the average from both the "pole" and "hand" experiments

Pole Sander DDM Model 600

On the afternoon of the fourth day of the study, one room was sanded using the Pole Sander DDM Model 600 The average per second voltage observed was 0 017, which is close to the corresponding means observed for the Sand & Kleen and the Sand Duster with Pullman Vacuum Cleaner When the logarithm of this value, -4 07, is compared to the means of the four controls on the logarithmic scale, the following differences can be found This value is more than 28 times the estimated standard deviation lower than the mean average per second voltage for the without control sander Thus, the Sand Duster with Pullman Vacuum Cleaner appears to reduce the concentration of dust relative to the without control sander The value of -4 07 is also more than nine times the estimated standard deviation below the mean average per second voltage for the Sand Duster with Commercial Vacuum Cleaner. Thus, the Sand Duster with Pullman Vacuum Cleaner appears to reduce the concentration of dust relative to the Sand Duster with Commercial Vacuum Cleaner. However, while -4 07 is below the means for the Sand n' Clean and the Sand Duster with Pullman Vacuum Cleaner, respectively, such a value or one lower could, with substantial probability, be the result of just random variation in the absence of a real difference

The value of the single observation for the Pole Sander DDM Model 600 is displayed with the simultaneous confidence intervals for the means of the other controls studied in Figure 4

Average-per-second Voltage as a Predictor of Personal Breathing Zone Dust Concentration

The relation between average-per-second voltage measurements (voltage) and personal breathing zone dust concentration measurements (concentration) was studied to determine the feasibility of predicting the latter from the former There were 16 observations with useable measurements on both variables Several regression analyses were performed using either weighted or non-weighted observations The several model resulted in squared correlations (r-squares) greater than 0 95 The most satisfactory analysis used a model linear in voltage and without an intercept and no weights The r-square was nearly 0 98 (see Figure 6). However, the data included five voltage measurements in a range from 91 to 260 while the remaining voltages were from 0 3 to 4 5 Much of the high correlation and form of the model reflected the difference between those two groups of observations When only the eleven lower voltage observations were studied, the r-square dropped to below 0 86 and there was evidence of nonlinearity When the high range of voltages were studied, a simple model linear in voltage and without an intercept resulted in an r-square of greater than 0.98 (see Figure 7) However, the most satisfactory model for the large concentration measurements was quite consistent with that for all of the observations No intercept is required in either case and the coefficients of voltage were nearly identical 235 04 for the large concentration case and 235.95 for all observations In Figure 6 the observations which had no concentration measurements were given a value of 0 in order to plot the predicted values, but these observations had no influence on the fitting of the model.

References

Henry Scheffe', The Analysis of Variance New York, John Wiley & Sons, Inc, 1959

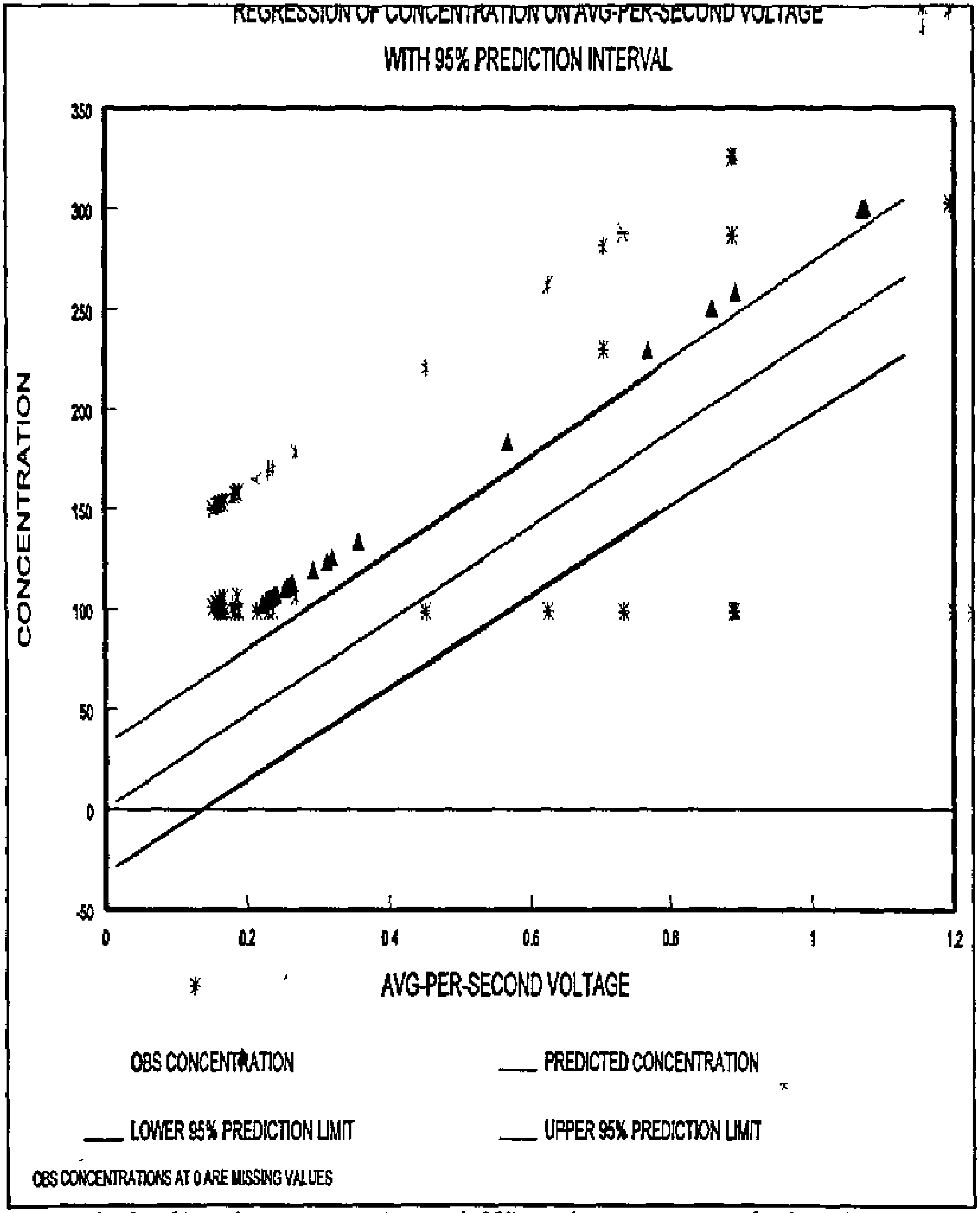


Figure 6 Predicted concentration and 95% prediction intervals based on average-per-second voltage all observations with voltage and concentration were used to fit the model

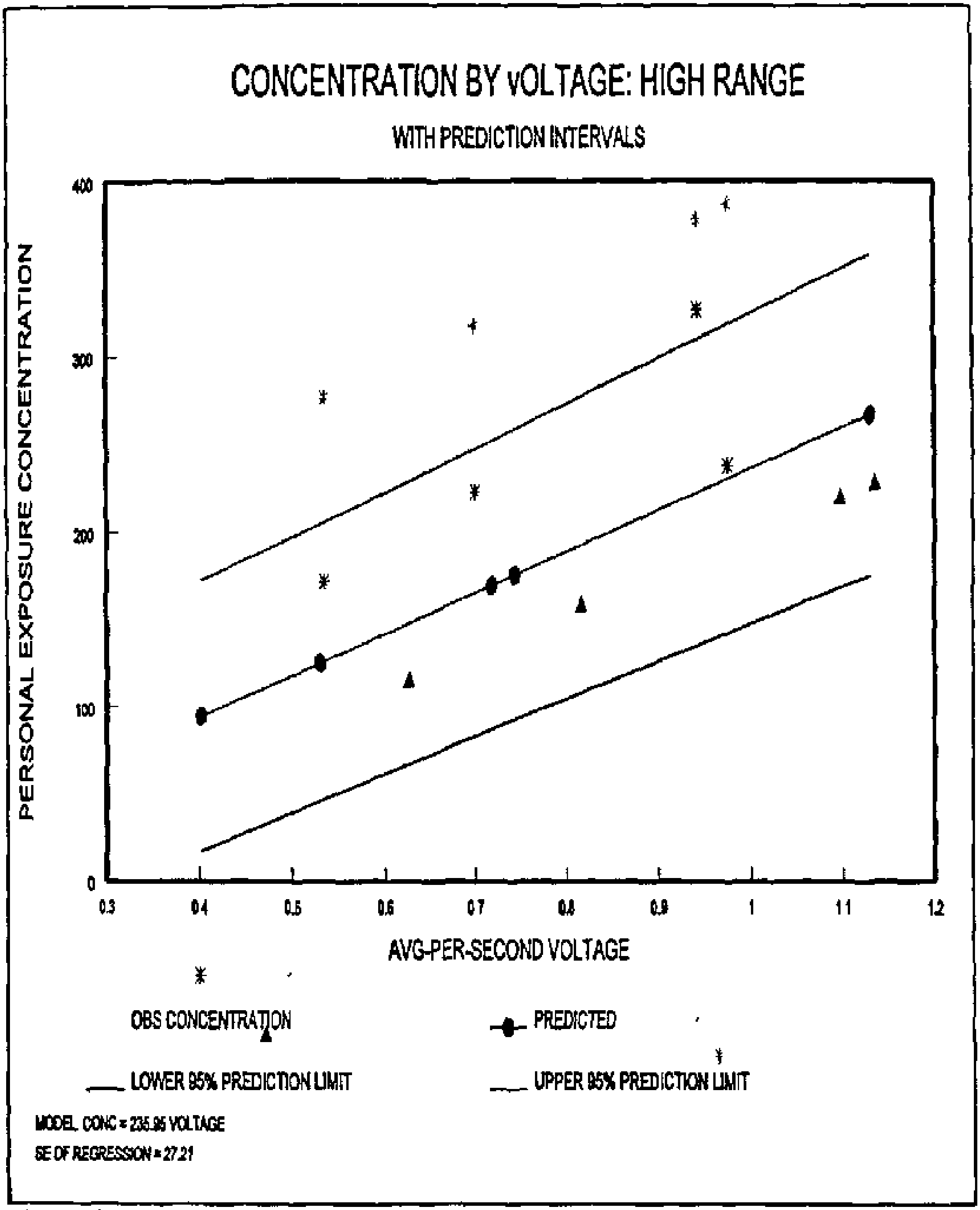


Figure 7 Predicted concentrations and 95% prediction interval based on observed average-per-second voltages model fit for observed concentrations greater than 50

To Kenneth Mead
From Thomas Fischbach
Subject Report on the Statistical Analysis of Hand Sanding Controls

Study Description, Design, and Objectives

The setup for this experiment was similar to that for the study of the pole sanding controls Three hand sanding devices were studied Fibatape, Sand & Kleen, and No Control To compare these to pole sanding, a fourth device was Pole W/O Control A control is designed to reduce the operator's exposure to dust However, all of these sanding devices are referenced as "controls" even though two had no control of dust exposures Six nearly identical rooms were plastered and then sanded by an operator following a predetermined scheme and sequence which randomly assigned each CONTROL to one or two rooms The objective of the study is to determine if these CONTROLs generate different dust concentrations in the nearby air and, if so, which CONTROLS differ from each other and by how much

A BLOCK is a random assignment of the four controls to the six rooms Blocks were designed in pairs termed SETUPS In one block of a setup, two controls were assigned to two rooms each and the remaining two controls were assigned to one room each In the second block of a setup this is reversed as the former two controls are assigned to one room each and the latter two controls are assigned to two rooms each The assignments of controls to rooms was random subject to the constraint just described and one described in the next paragraph Both blocks of a setup were to be run at the same time of day, i e , morning or afternoon This would prevent confounding of the effects of the controls with that for time of day, which might reflect the effects of differences in time the rooms were permitted to dry after being plastered However, one full setup (on two mornings) and only one block of a second setup (on one afternoon) could be run Because of this restriction, there was partial confounding between the effects of the controls and that of drying time

In addition, the experiment was designed to assign each of the six rooms to each of the four controls an equal number of times if enough setups were run However, because only one full setup plus one block of a second setup could be run, this "balance" was not achieved None of the three sanding devices assigned to the room designated as "D" had dust controls. But, all three of the devices assigned to the room designated as "A" had dust controls Thus, if the presence or absence of a dust control determined different levels of dust concentration, this would induce spurious differences among the six rooms While there was no prior reason to expect differences among the rooms would result in different levels of dust concentration, if such were the case this would induce spurious differences between the controls with and without dust controls

An equipment malfunction occurred for 24 seconds in the sole run in the second block of the first setup using the Sand & Kleen control

Analysis

1 Data Preparation

Because of restrictions on the study, only 18 observations were available Two data-sets were formed The first, termed the "better" set, used all the collected data except for those collected in the 24 seconds when the equipment malfunction occurred as previously described The second dataset, termed the "worse" set, used all the data including those collected during the 24 seconds of equipment malfunction

The voltage responses of the area sampler were used without conversion to concentrations A voltage response was obtained for each second while sanding was performed Because the duration of sanding a room varied, the response measure analyzed was the average voltage per second over all seconds of sanding for a room. A preliminary analysis revealed that the standard deviation of the average voltage was proportional to the mean voltage for any subgroup when the data were grouped by control or room Thus, the natural logarithm of the average voltage per second was used as the response variable for analysis although results using the original scale were consistent with those on the logarithmic scale

2 Main Results

The results obtained from the analyses of the two datasets were consistent and revealed no meaningful differences Thus, only those for the "better" data are reported

Time to complete sanding and sequence of a run within a block were not analyzed because of the negative results of such analyses for the "Pole" experiment and because of the limited number of observations in the "Hand" experiment The factors considered were SETUP, block within SETUP (BLOCK(SETUP)), ROOM, and CONTROL. The CONTROL by SETUP and the CONTROL by BLOCK(SETUP) interactions were analyzed and estimated as possible error terms when comparing controls. A series of models were fit to the data to determine the one most justifiable and the one which would be most informative about the true differences among the controls Both fixed effect and mixed model analyses [with SETUP and BLOCK(SETUP) and the interactions as random effects] based analyses were performed

The small sample size hampered the interpretation of the results and the selection of the most appropriate model However, in all cases the effects of CONTROL were statistically significant at least at the 0 036 level and at the 0.001 level in the final model The effects of the other factors depended on what other factors were included in the model and whether they were entered in the model before or after CONTROL. The statistical significance of ROOM and/or BLOCK(SETUP) occurring when entered in the model before CONTROL either vanished or diminished to marginality when entered after CONTROL By far the largest observed room difference was between room "D" and average of the other rooms Such a difference is consistent with a large difference associated with the use of a dust control Since there was no prior reason to expect such factors, e g , room, setup, etc , to be associated with dust concentration and because of the confounding caused by restrictions on the conduct of the experiment, it was concluded that the only factor of importance was CONTROL and all others, including the interaction terms -- which were never statistically significant, were dropped All results to be reported are from the model which included only CONTROL

3 Analysis and Estimation of Differences Among Controls

The voltage responses for the two devices with dust controls were statistically significantly lower than for either of the two devices without dust controls at least at the 0 05 level using Scheffe's method of multiple comparison (other methods resulted in the same result) However, the difference between the two devices with dust controls and that between the two devices without dust controls were not statistically significant at the 0 05 level even for pairwise t-tests Simultaneous ninety-five percent confidence intervals for the means of the logarithm of the average per second voltage of the four controls are shown in Table 1 These were constructed using Scheffe's method

TABLE 1 SIMULTANEOUS 95% CONFIDENCE INTERVALS FOR MEAN OF AVERAGE PER SECOND VOLTAGE ON THE LOGARITHMIC SCALE					
CONTROL HAND SANDING DEVICE	LOG OF AVERAGE PER SECOND VOLTAGE				VERTICAL LINES CONNECT CONTROLS NOT DIFFERENT
	LOWER BOUND	MEAN	UPPER BOUND	STANDARD ERROR	
SAND & Kleen	-4 03	-3 34	-2 66	0 19	|
FIBATAPE	-3 92	-3 23	-2 55	0 19	|
NO CONTROL WITH POLE	-1 56	-0 70	0 19	0 25	|
NO CONTROL	-1 02	-0 26	0 50	0 25	|

This information is presented for the original voltage scale in Table 2

TABLE 2 QUASI-SIMULTANEOUS 95% CONFIDENCE INTERVALS ON THE VOLTAGE SCALE					
CONTROL. HAND SANDING DEVICE	AVERAGE PER SECOND VOLTAGE				
	LOWER BOUND	MEAN	UPPER BOUND	STANDARD ERROR	VERTICAL LINES CONNECT CONTROLS NOT STATISTICALLY DIFFERENT
SAND & KLEEN	0 02	0 04	0 07	0.0070	|
FIBATAPE	0 02	0 04	0 08	0.0078	|
NO CONTROL WITH POLE	0.21	0.51	1.23	0.1295	|
NO CONTROL	0 36	0 78	1.68	0 1712	|

This information is graphically displayed in Figure 1.

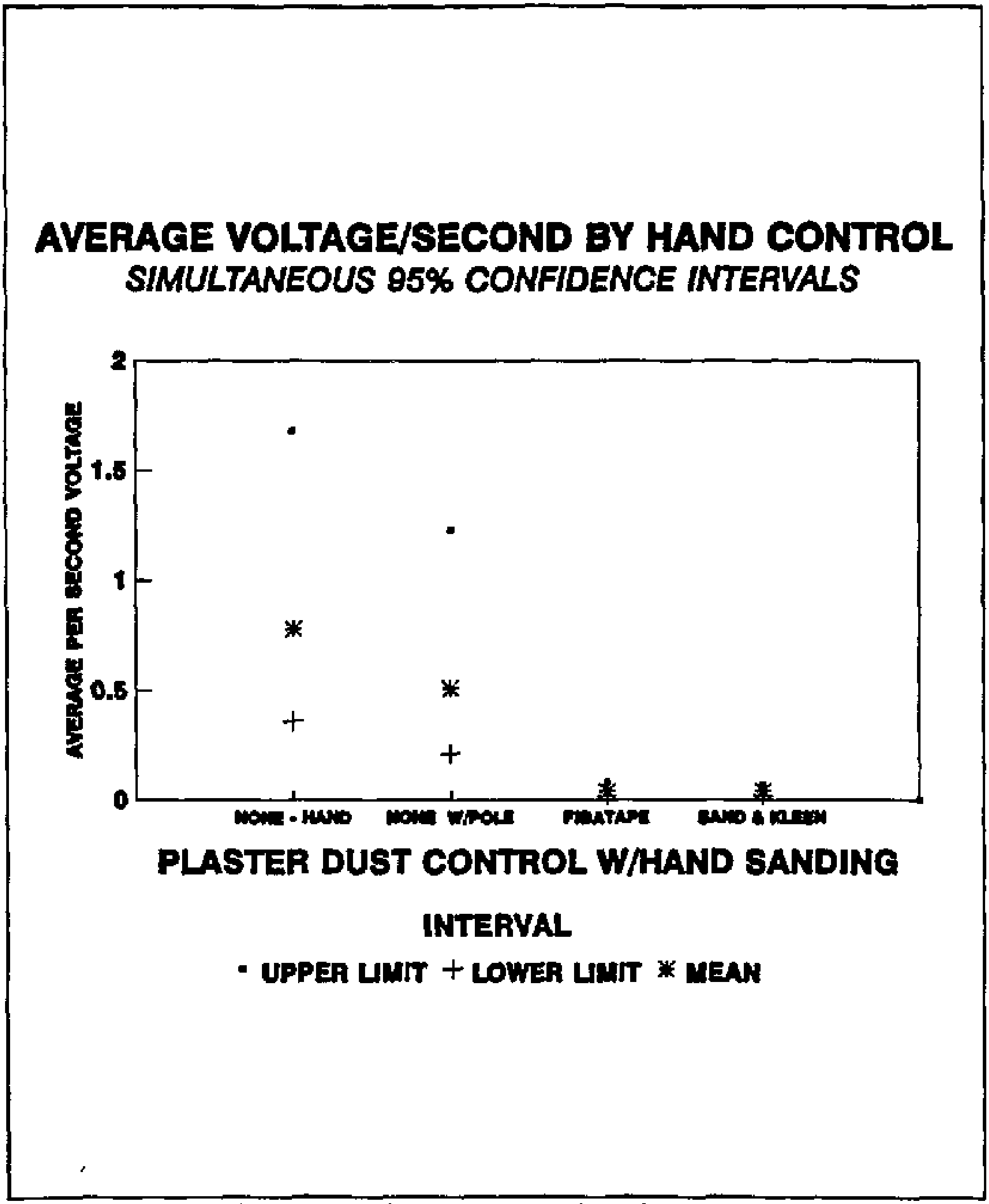


Figure 1 Estimated Average Voltage per Second Reading for Area Dust Sampler During Sanding of an Experimental Room

A more meaningful way to present this information is in terms of the dust concentration of a sanding device with a dust control as a percent of the dust concentration when no dust control is used This is presented in Table 3 Table 3 is based on 95% simultaneous confidence intervals for the corresponding differences between the logarithms of the average per second voltage Since average per second voltage is directly proportional to dust concentration, these are the logarithms of the ratios of dust concentrations of devices with dust controls to devices without dust controls These 95% simultaneous intervals were transformed back to the original scale to construct intervals which are approximately 95% simultaneous intervals on the original scale

TABLE 3 QUASI SIMULTANEOUS 95% CONFIDENCE INTERVALS OF THE DUST CONCENTRATION OF A SANDING DEVICE WITH A DUST CONTROL AS A PERCENTAGE OF THAT FOR NO CONTROL

SANDING DEVICE	BASE FOR PERCENTAGE	PERCENTAGE OF NO CONTROL CONCENTRATION		
		LOWER BOUND	*MEAN*	*UPPER BOUND*
SAND & KLEEN	NO CONTROL	1 89%	4 76%	11 96%
FIBATAPE	NO CONTROL	2 11%	5 30%	13 33%
POLE SANDING WITH NO CONTROL[1]	NO CONTROL	23 45%	66 98%	191 35%
POLE SANDING WITH NO CONTROL[2]	NO CONTROL	29 26%	65 62%	147 17%
SAND & KLEEN	POLE W/O CONTROL[1]	2 69%	7 35%	20 04%
SAND & KLEEN	POLE W/O CONTROL[2]	3 55%	7 50%	15 82%
FIBATAPE	POLE W/O CONTROL[1]	3 00%	8 19%	22 35%
FIBATAPE	POLE W/O CONTROL[2]	3 96%	8 36%	17 65%

[1] Based on hand sanding experimental data only
[2] Based on average of both the hand sanding and pole sanding experiments

The comparative percentages of the devices with a dust control and the pole without a pole to hand sanding without a control are graphically displayed in Figures 2 and 3 In the Figure 2 only the data from the hand sanding experiment while in Figure 3 the results for the pole without a control are based on an average of the data from both the hand sanding and dust sanding experiments

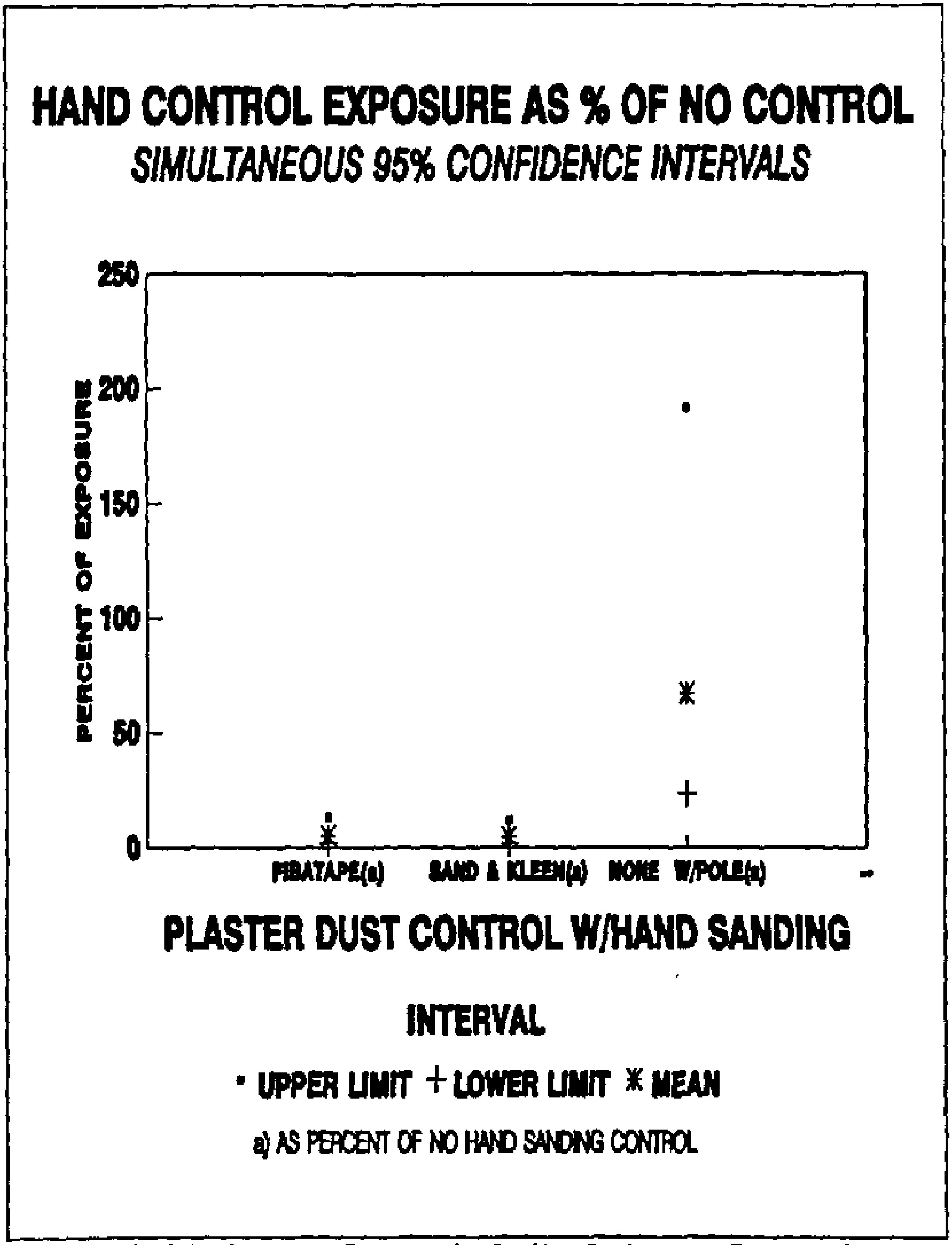


Figure 2 Hand Sanding Dust Exposure by Sanding Device as a Percent of Exposure When No Dust Control Is Used Based on Hand Sander Experiment Data

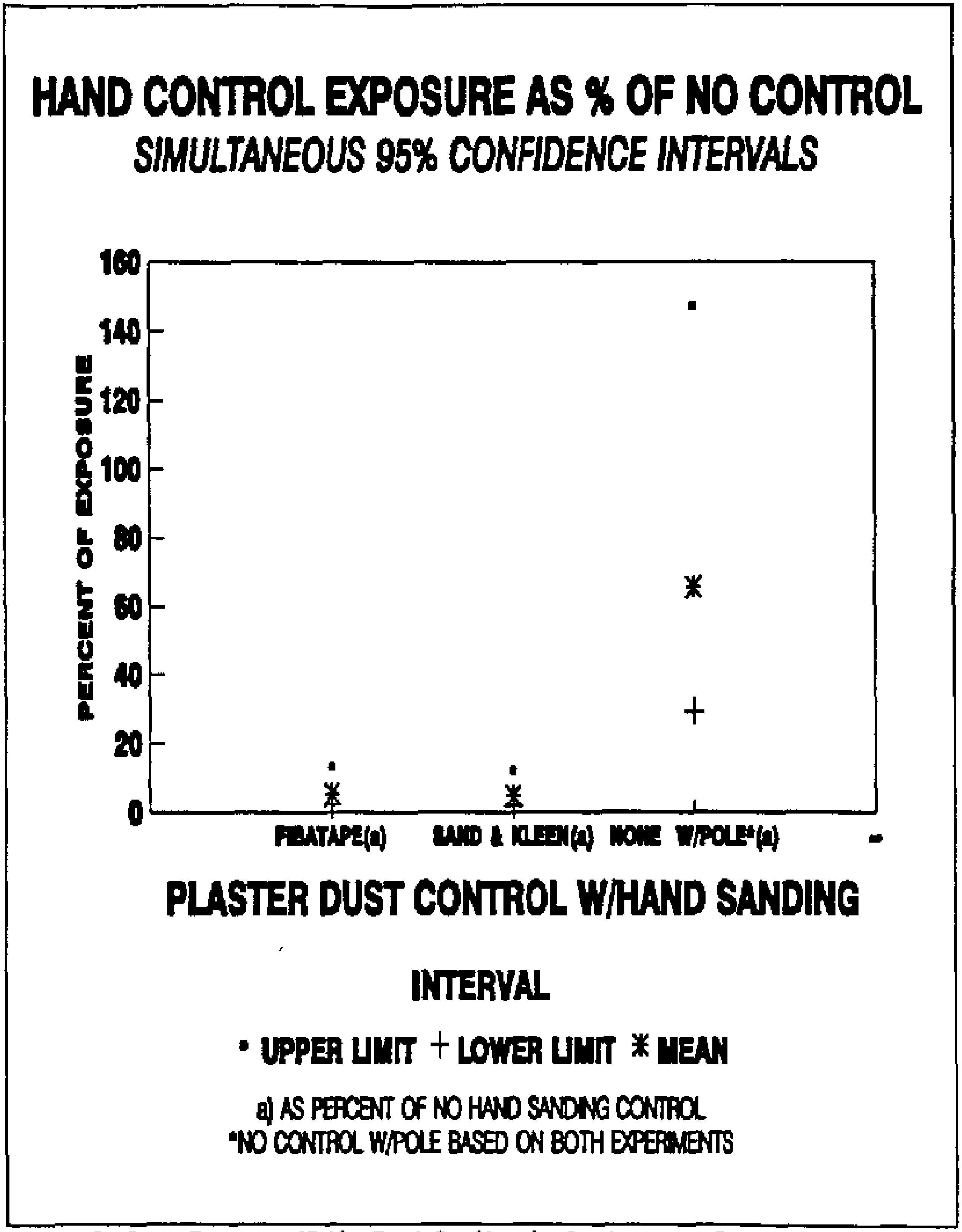


Figure 3 Dust Exposure While Hand Sanding by Device as a Percent of Exposure When No Dust Control Is Used Pole Without Dust Control Performance Based on both the Hand and the Pole Experiments