IN-DEPTH SURVEY REPORT

EVALUATION OF A VENTILATION CONTROL FOR CASTING CLEANING IN A FOUNDRY

at

General Castings -- Powers Street Facility
Cincinnati, Ohio

REPORT WRITTEN BY
Michael G Gressel

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Public Health Service
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National Institute for Occupational Safety and Health
Division of Physical Sciences and Engineering
4676 Columbia Parkway, R-5
Cincinnati, Ohio 45226

PLANT SURVEYED	General Castings Co Powers Street Facility 1735 Powers Street Cincinnati, Ohio 45223 (513) 541-6121
SIC CODE	3321 Gray and Ductile Iron Foundries
SURVEY DATES	April 12, 1993 May 25, 1993
SURVEY CONDUCTED BY	Michael G Gressel James P Agee Charles S Hayden Ronald J Kovein
EMPLOYER REPRESENTATIVE CONTACTED	Thomas Wheatley, Plant Manager
EMPLOYEE REPRESENTATIVE CONTACTED	No Union
MANUSCRIPT PREPARED BY	Deanna L Elfers

DISCLAIMER

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ABSTRACT

A study was conducted to evaluate the effectiveness of a local exhaust ventilation system for a foundry casting cleaning operation In this operation, an operator cleans castings using a variety of hand-held chipping and grinding tools The local exhaust ventilation system consisted of a downdraft booth outfitted with a turntable to make casting manipulation easier The original control system consisted of only an exhaust duct terminating approximately 3 ft off of the floor, at a distance of approximately 6 ft from the casting cleaning workstation The new local exhaust ventilation system was connected to the existing plant ventilation system through the original ductwork A direct reading instrument was used to measure the operator's aerosol exposure concentration for both the original configuration and for the modified setup Depending upon the type of tool used, the local exhaust ventilation system reduced exposures from 60 to 90 percent from the original configuration These reductions were found to be statistically significant

ACKNOWLEDGEMENTS

The following persons are recognized for their assistance in conducting this project Mr Daniel S Watkins, for his skill in constructing the ventilated workstation evaluated in this study, Mr Daniel R Farwick, for his assistance in preparing the equipment survey used in the two surveys, Mr James P Agee for his assistance in installing the workstation and collecting the survey data, Mr Ronald J Kovein and Mr Charles S Hayden, for their assistance in collecting the survey data, and Mr Thomas J Fischbach for his assistance in conducting the statistical analysis of the survey data

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) is the primary federal organization engaged in occupational safety and health research Located in the Department of Health and Human Services, it was established by the Occupational Safety and Health Act of 1970 This legislation mandated NIOSH to conduct a number of research and education 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 has been given the lead within NIOSH to study the engineering aspects of health hazards prevention and control

Since 1976, ECTB has conducted several assessments of health hazard control technology based on industry, common industrial process, or specific control techniques The objective of each of these studies has been to document and evaluate effective techniques for the control of potential health hazards in the industry or process of interest, and to create a more general awareness of the need for, or availability of, effective hazard control measures

In February of 1992, a Health Hazard Evaluation (HHE) was conducted at the General Castings - Powers Street Facility in Cincinnati, Ohio, in response to a management request to evaluate worker exposures [1] This gray and ductile iron foundry is housed in a masonry building and operated one shift with 32 employees This initial survey looked at operations in the entire plant and included collection of samples to determine personal respirable silica exposure concentrations The survey results showed high respirable silica exposure concentrations for the workers in a number of areas including those engaged in casting cleaning operations The respirable silica concentrations that these workers were exposed to ranged from 124 to 160 $\mu g/m^3$, 8-hr time-weighted-average (TWA) The results of this survey along with the results of other studies, indicates that respirable silica exposure concentrations are not well controlled during casting cleaning [2] The purpose of this study was to evaluate the effectiveness of a ventilation control for reducing the silica exposure concentrations

CASTING CLEANING IN FOUNDRIES

Most metal castings made in foundries use molds made from a sand and binder system The binder allows the sand particles to adhere to one another so the molds can be formed into the proper shape The General Castings - Powers Street Facility used green sand, a mixture of sand, clay, water, and coal dust, for molds For complicated castings, cores may be used to provide wanted void spaces in the casting This plant used three different core making processes, shell, oil baked, and no-bake

After they are assembled, the molds are filled with molten metal The methods for pouring the molds vary greatly with the size and type of foundry Following the mold pouring process, the castings are allowed to cool The castings are then removed from the molds in a process called shakeout Like the pouring operation, the shakeout operation can vary greatly with the type of foundry After shakeout, the casting may be placed in a shot blast machine to remove the greatest portion of sand adhered to the new casting While the shot blast machine will remove a large amount of the sand, some sand will be embedded or burnt into the casting It is this burnt in sand along with metal appendages that must be removed in the casting cleaning operation

Castings are cleaned by hand using pneumatic chipping and grinding tools The workers use the chipping and grinding tools to remove the appendages and any burnt in sand The grinding of the sand produces respirable silica particles, presenting a hazard to the workers The workers use a variety of tools including cup grinders, cone grinders, pneumatic chisels, and abrasive wheels Engineering controls for this operation are sparse, many plants have no controls in place or while others may have ineffective controls such as a poorly designed ventilated table [2] The employees who cleaned the castings at this facility used NIOSH/Mine Safety and Health Administration (MSHA) approved air-purifying respirator helmets which had high efficiency particulate air (HEPA) filters and built-in face shields Safety shoes and safety glasses were required in this area as well as throughout the rest of the plant

EXPOSURE LIMITS AND HEALTH EFFECTS

Crystalline silica exposures are of primary concern in the study of the casting cleaning operation at this facility Silica may be present in at least three crystalline forms (alpha quartz, cristobalite, and tridymite), as well as amorphous (noncrystalline) forms Amorphous silica is usually considered to be of low toxicity and may produce X-ray changes in the lung without disability [3,4] The crystalline forms of silica can cause severe lung damage (silicosis) when inhaled Silicosis is a form of pulmonary fibrosis caused by the deposition of fine particles of crystalline silica in the lower portions (alveoli) of the lungs Symptoms usually develop insidiously, with cough, shortness of breath, chest pain, weakness, wheezing, and nonspecific chest illness Silicosis usually occurs after years of exposure, but may appear in a shorter time if exposures are very high

The current U S Department of Labor (OSHA) Permissible Exposure Limits (PEL)[5] for respirable crystalline silica is calculated from Equation 1

$$\mathrm{PEL} = \frac{10\,\mathrm{mg/m^3}}{\%SiO_2 + 2} \qquad (1)$$

OSHA had changed the PEL to 0 1 mg/m³ in 1989 under the Air Contaminants Standard In July 1992, the 11th Circuit Court of Appeals vacated this standard OSHA is currently enforcing the limit calculated by Equation 1, however, some states operating their own OSHA approved job safety and health programs will continue to enforce the 0 1 mg/m³ standard NIOSH has set its Recommended Exposure Limits (REL)[3] at 0 05 mg/m³ These values are 8-hour time weighted averages The OSHA PEL's are required to consider the feasibility of controlling exposures in various industries where the agents are used, the NIOSH REL's, by contrast, are based primarily on concerns relating to the prevention of occupational disease

This discussion about the exposure limits is presented to put the exposures associated with this operation into perspective The HHE that was conducted at this plant in February 1992 showed that respirable silica exposures exceeded the exposure limits discussed here These exposure limits and the health effects of these exposures indicate a need for some control intervention

VENTILATION CONTROL DESIGN

The ventilation control system evaluated in this study was a downdraft booth The intended function of this control is to draw the air contaminant (silica) away from the worker's breathing zone A secondary benefit of this system is that it will enclose the contaminant generation source reducing the infiltration of the contaminant to other areas of the plant

A diagram of the ventilation control system is shown in Figure 1 It consists of a booth with exhaust ventilation at the back of the work surface This design was taken from the ACGIH Ventilation Manual [6] A turntable, shown in Figure 2, was provided to allow the worker easy access to the various grinding surfaces of the casting There was a damper on another branch of the ventilation system which served as a saw located elsewhere in the facility Velocity measurements at the table of the workstation showed that the exhaust volume was approximately 5400 cfm with the damper closed and approximately 2900 cfm with the damper opened The original ventilation system consisted only of an exhaust duct terminating approximately 6 ft from the grinding table The flow rate through this duct was approximately 3200 cfm with the damper opened and 5600 cfm with the damper closed All exposure measurements were made with the damper in the opened position

SAMPLING METHODS

A direct reading instrument was used to measure respirable dust as a surrogate for respirable silica The direct reading instrument used, the Hand-Held Aerosol Monitor (HAM) (PPM Inc , Knoxville TN), is a light scattering device which responds to any dust in the respirable range The response, however, is dependant upon the nature of the contaminant Since this study is concerned about differences between workstation configuration and not the actual magnitude of the exposure, data from the HAM can be used as a relative measure of the worker's respirable silica concentration This would require the following two assumptions first, that the percentage concentration of silica in the total dust stream remains relatively constant over all sampling runs, and second, that the particle size distribution of the total dust stream remains constant Given the operation being evaluated, these two assumptions seem to be reasonable To improve the instrument response, the HAM was operated in an active mode, using a sampling pump to draw air though the

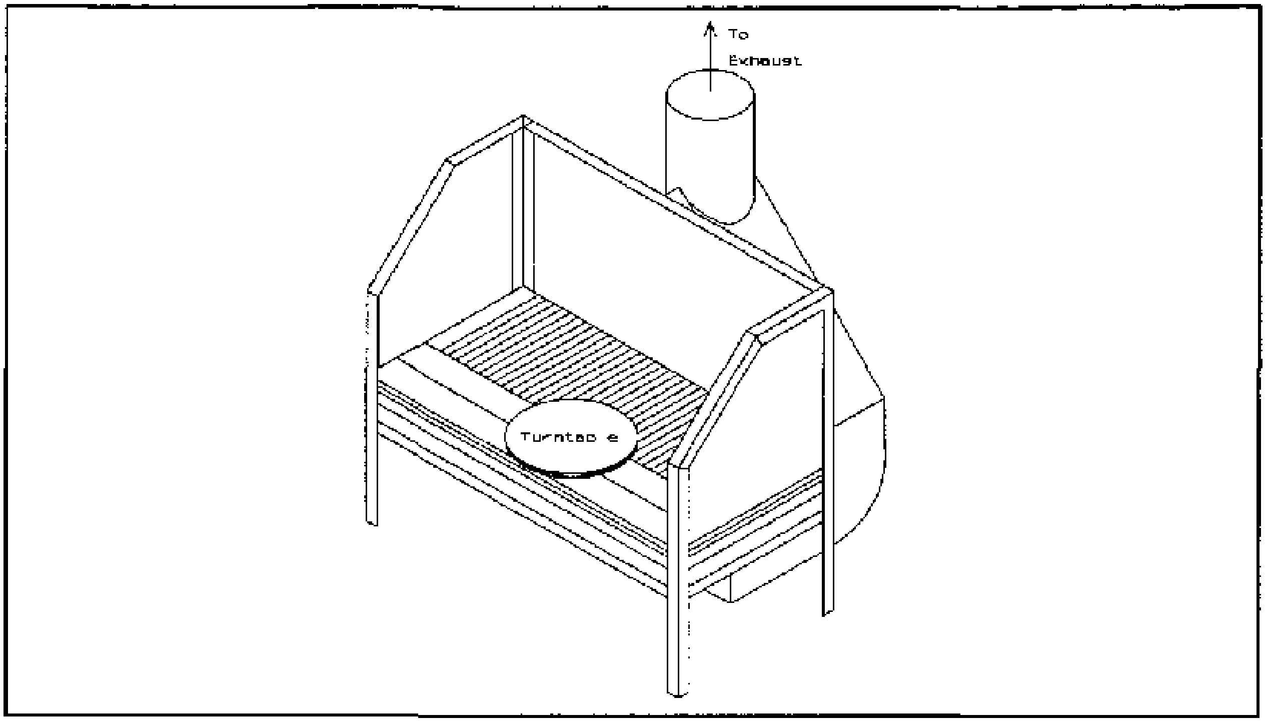

Figure 1 Diagram of ventilated casting cleaning workstation

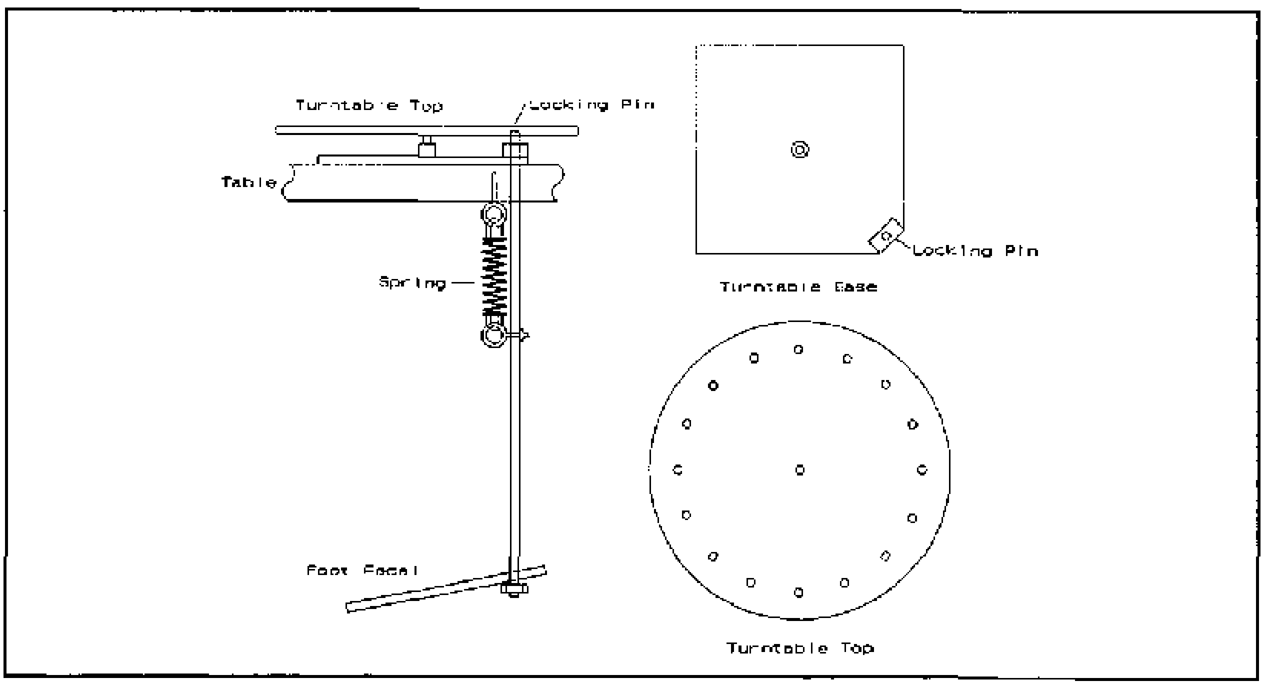

Figure 2 Diagram of casting cleaning turntable

sensing chamber of the HAM The active mode improved the response since the instrument did not have to rely on random air currents to transport the contaminant into the instrument

The output from the HAM was connected to a Rustrak Ranger I data logger (Rustrak, East Greenwich, RI) for data collection and storage The data logger was downloaded to an IBM compatible computer at intervals of no more than one hour Once the data was downloaded to the computer, it was stored in data files for subsequent data analysis

In addition to the aerosol monitoring, the entire sampling operation was recorded on videotape to document tool usage during the sampling periods The clock on the camera was synchronized with the clock of the data logger so that the activities recorded on tape could be matched with the exposure data in the data files After the sampling was completed, the video recordings were reviewed and tool usage variables were entered into the exposure data set

STUDY DESIGN

The design of this study was simple, consisting of the following two sampling periods one before the ventilated workstation was installed and one after the ventilated workstation was installed The primary goal of the study was to determine the overall effectiveness of the workstation at reducing the workers respirable aerosol exposure A secondary goal was to determine the effectiveness of the workstation with each of the tools used The first sampling period yielded over 8,500 measurements during grinding (The operator spent more than 8,500 seconds using one of the four grinding tools during this period) The second sampling period resulted in over 3,100 readings The data from both of the sampling periods were combined for the data analysis

DATA ANALYSIS AND RESULTS

The goal of the data analysis for this study was first, to determine the overall and by-tool exposures for each sampling period, and second, to determine if the differences between the exposures for the sampling periods were statistically significant For the grinding operation, the operator used the following four different tools a 6-in cup grinder, an in-line cone grinder, a 9-in cut-off wheel, and a pneumatic chisel Because a nonspecific direct reading instrument was used to measure exposure concentrations, all exposures are given in terms of relative concentration The numbers given are not to be taken as actual concentrations, but rather, as concentrations relative to other exposures measured in this study

Because of instrument and environmental response issues, the data were adjusted for a lag of 5 seconds [7] To reduce potential autocorrelation effects, the data were censored, extracting every fifth second reading for the data analysis [7] The data was then log-transformed, and the geometric mean and geometric standard deviation were determined for the overall exposures and by-tool exposures for each sampling period These results are given in

Table 1 The data were further analyzed to determine if the differences between the geometric means were significant by modelling the data using the General Linear Means procedure in SAS (SAS Institute, Cary, NC), a statistical analysis program The parameters of this model were used to estimate differences in concentrations for the different tools A linear contrast was then run in SAS to produce a t-test to determine if the differences were statistically significant The model, the SAS program, and a partial listing of the output of the SAS analysis are given in the Appendices Additional details concerning the analysis can be found in other references [8,9] The results of this analysis showed that, on an overall basis, the ventilated workstation reduced the operator's exposure and this reduction was statistically significant (probability > t = 0 0001) In addition, the exposures during the use of the cup grinder, the cone grinder, and the cut-off wheel were all reduced, and the reductions were statistically significant (probability > t = 0 0001) The use of the pneumatic chisel increased the exposure concentrations slightly, but this was not a statistically significant difference (probability > t = 0 3334) In addition to the geometric means and standard deviations, Table 1 also gives the percentage reduction in the operator's dust concentration due to the ventilated workstation

Table 1 Geometric means and geometric standard deviations for pre-workstation and post-workstation relative exposures

	Pre-Workstation			Post-Workstation			% Reduction Pre- vs Post-
	n	GM	GSD	n	GM	GSD	
Overall Grinding	1699	0 10	3 93	579	0 028	4 54	72%
Cup Grinder	569	0 21	3 50	311	0 021	4 57	90%
Cone Grinder	919	0 053	2 35	170	0 021	2 65	60%
Cut-off Wheel	142	0 82	2 77	64	0 23	2 33	72%
Pneumatic Chisel	69	0 025	2 02	34	0 032	4 82	-28%

n - Number of Measurements GM - Geometric Mean
GSD - Geometric Standard Deviation
Negative percentage indicates concentration increase
Differences for the pneumatic chisel were not statistically significant

In the post-workstation configuration, a fifth tool, a different type of pneumatic chisel, was used for a short period of time Originally, the data for this tool was included with the data for the other pneumatic chisel for the data analysis, The analysis showed that there was a statistically significant increase in exposure when using the pneumatic chisel at the ventilated workstation However, upon further investigation, this second chisel was found to be of a slightly different design Therefore, the exposure data for the second pneumatic chisel was not included in the final analysis of the data

CONCLUSIONS AND RECOMMENDATIONS

The results of the sampling conducted in this facility indicated that the installation of the ventilated workstation resulted in a statistically significant decrease in the operator's dust exposure Looking at the exposures on a tool-by-tool basis, the ventilated workstation resulted in statistically significant exposure reductions for the cup grinder, the cone grinder, and the cut-off wheel The percentage by tool ranged between 60 percent and 90 percent The time weighed average exposures for these workers would also be expected to decrease since the use of the tools is the primary source of silica exposure The magnitude of this decrease would be dependant on the worker's tool usage

There was no statistically significant difference in the exposures while using the pneumatic chisel The exposures while using the pneumatic chisel were also among the lowest of all the exposures This indicates that little dust is generated by the use of this tool, or that any particles that are generated are larger than respirable The data that was collected during the use of the second pneumatic chisel showed significant increases in exposure concentration This increase may have been due to the tool exhaust rather than the material removed from the casting Tool exhaust (oil mist from the compressed air) could also be a source of aerosol exposure during the use of the other tools as well These tools should be evaluated further to determine if tool exhaust is the cause of the concentration increases, and, if this proves to be the cause, alternative tools should be considered

The effectiveness of the ventilated workstation shows how local exhaust ventilation can effectively control worker exposures if applied properly The original configuration did not provide efficient control of the aerosol created by the grinding operation Installation of the ventilated workstation significantly reduced the operator's exposure without increasing the amount of air exhausted by the ventilation system Installation of similar workstations should be considered at other casting cleaning operations as a means of reducing other operators' exposures

REFERENCES

1 NIOSH [1993] Hazard evaluation and technical assistance report General Castings -- Powers Street Facility Cincinnati, OH 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 (In-press)

2 NIOSH [1978] A technical report an evaluation of occupational health hazard control technology for the foundry industry Cincinnati, OH U S Department of Health, Education and Welfare, Public Health Service,

Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No 79-114, pp 157-177

3 NIOSH [1975] NIOSH criteria for a recommended standard occupational exposure to crystalline silica Cincinnati, OH U S Department of Health, Education and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No 75-120, NTIS No PB 246-697/A07

4 NIOSH [1981] Current Intelligence Bulletin 36 silica flour, silicosis (crystalline silica) Cincinnati, OH U S Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No 81-137, NTIS No PB 83-101-758/A02

5 CFR [29 CFR 1910 100 (1989)] Code of Federal regulations Washington, DC U S Government Printing Office, Office of the Federal Register

6 ACGIH [1992] Industrial ventilation a manual of recommended practice 21st ed Cincinnati, OH American Conference of Governmental Industrial Hygienists

7 O'Brien DM, Fischbach TJ, Cooper TC, Todd WF, Gressel MG, Martinez KF [1989] Acquisition and spreadsheet analysis of real time dust exposure data a case study Appl Ind Hyg 4(9) 238-243

8 Mendenhall W [1968] Introduction to linear models and the design and analysis of experiments Belmont, CA Duxbury Press, pp 148-150

9 SAS [1988] SAS/STAT™ user's guide Cary, NC SAS Institute, Inc, pp 549-641

APPENDIX A MODEL

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_1 X_4 + \beta_6 X_2 X_4 + \beta_7 X_3 X_4$$

Where Y = Predicted relative exposure

X_1 = 1 if tool 1, otherwise 0

X_2 = 1 if tool 2, otherwise 0

X_3 = 1 if tool 3, otherwise 0

X_4 = 1 if tool 4, otherwise 0

β_{1-7} = model parameters

APPENDIX B   SAS PROGRAM

```
Data POW,
  infile 'c \net123\power\powCEN2 prn',
  input READING TOOL BEF_AFT,
run,
Proc sort,
  by TOOL,
run,

proc glm,
  class TOOL BEF_AFT,
  model READING=TOOL|BEF_AFT /SOLUTION,
ESTIMATE 'TOOL 1 PRE' INTERCEPT 1 TOOL 1 0 0 0 BEF_AFT 1 0 TOOL*BEF_AFT
         1 0 0 0 0 0 0 0 /E,
ESTIMATE 'TOOL 1 POST' INTERCEPT 1 TOOL 1 0 0 0 BEF_AFT 0 1 TOOL*BEF_AFT
         0 1 0 0 0 0 0 0 /E,
ESTIMATE 'TOOL 2 PRE' INTERCEPT 1 TOOL 0 1 0 0 BEF_AFT 1 0 TOOL*BEF_AFT
         0 0 1 0 0 0 0 0 /E,
ESTIMATE 'TOOL 2 POST' INTERCEPT 1 TOOL 0 1 0 0 BEF_AFT 0 1 TOOL*BEF_AFT
         0 0 0 1 0 0 0 0 /E,
ESTIMATE 'TOOL 3 PRE' INTERCEPT 1 TOOL 0 0 1 0 BEF_AFT 1 0 TOOL*BEF_AFT
         0 0 0 0 1 0 0 0 /E,
ESTIMATE 'TOOL 3 POST' INTERCEPT 1 TOOL 0 0 1 0 BEF_AFT 0 1 TOOL*BEF_AFT
         0 0 0 0 0 1 0 0 /E,
ESTIMATE 'TOOL 4 PRE' INTERCEPT 1 TOOL 0 0 0 1 BEF_AFT 1 0 TOOL*BEF_AFT
         0 0 0 0 0 0 1 0 /E,
ESTIMATE 'TOOL 4 POST' INTERCEPT 1 TOOL 0 0 0 1 BEF_AFT 0 1 TOOL*BEF_AFT
         0 0 0 0 0 0 0 1 /E,
ESTIMATE 'PRE-POST' BEF_AFT -1 1 /E,
ESTIMATE 'TOOL1 PRE-POST' BEF_AFT -1 1 TOOL*BEF_AFT -1 1 0 0 0 0 0 0 /E,
ESTIMATE 'TOOL2 PRE-POST' BEF_AFT -1 1 TOOL*BEF_AFT 0 0 -1 1 0 0 0 0 /E,
ESTIMATE 'TOOL3 PRE-POST' BEF_AFT -1 1 TOOL*BEF_AFT 0 0 0 0 -1 1 0 0 /E,
ESTIMATE 'TOOL4 PRE-POST' BEF_AFT -1 1 TOOL*BEF_AFT 0 0 0 0 0 0 -1 1 /E,
  MEANS TOOL BEF_AFT TOOL*BEF_AFT,
  OUTPUT OUT=OUT1 PREDICTED=PREDICTE RESIDUAL=RESIDUAL STUDENT=STUDENT,
PROC PLOT,
  PLOT RESIDUAL*PREDICTE,
  PLOT STUDENT*PREDICTE,
RUN,

PROC MEANS MEAN STD,
  BY TOOL BEF_AFT,
RUN,
```

APPENDIX C PARTIAL SAS OUTPUT

General Linear Models Procedure

Dependent Variable READING

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	2493 482049	356 211721	294 77	0 0
Error	2270	2743 190019	1 208454		
Corrected Total	2277	5236 672068			

R-Square	C V	Root MSE	READING Mean
0 476158	-42 20255	1 099297	-2 6048118

Source	DF	Type I SS	Mean Square	F Value	Pr > F
TOOL	3	1220 238113	406 746038	336 58	0 0001
BEF_AFT	1	1022 701012	1022 701012	846 29	0 0001
TOOL*BEF_AFT	3	250 542923	83 514308	69 11	0 0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
TOOL	3	935 4161706	311 8053902	258 02	0 0001
BEF_AFT	1	235 4366605	235 4366605	194 82	0 0001
TOOL*BEF_AFT	3	250 5429231	83 5143077	69 11	0 0001

Parameter	Estimate	T for H0 Parameter=0	Pr > |T|	Std Error of Estimate
TOOL 1 PRE	-1 55931571	-33 84	0 0001	0 04608492
TOOL 1 POST	-3 87553155	-62 17	0 0	0 06233541
TOOL 2 PRE	-2 93112146	-80 83	0 0	0 03626246
TOOL 2 POST	-3 84371976	-45 59	0 0	0 08431223
TOOL 3 PRE	-0 19307582	-2 09	0 0365	0 09225095
TOOL 3 POST	-1 48658986	-10 82	0 0001	0 13741212
TOOL 4 PRE	-3 68064464	-27 81	0 0001	0 13233980
TOOL 4 POST	-3 45777559	-18 34	0 0001	0 18852787
PRE-POST	-1 07486478	-13 96	0 0001	0 07700728
TOOL1 PRE-POST	-2 31621583	-29 88	0 0001	0 07752112
TOOL2 PRE-POST	-0 91259830	-9 94	0 0001	0 09177972
TOOL3 PRE-POST	-1 29351404	-7 82	0 0001	0 16550628
TOOL4 PRE-POST	0 22286905	0 97	0 3334	0 23034014

Parameter			Estimate	T for H0 Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		(β_0)	-3 457775588 B	-18 34	0 0001	0 18852787
TOOL	1	(β_1)	-0 417755958 B	-2 10	0 0355	0 19856601
	2	(β_2)	-0 385944176 B	-1 87	0 0618	0 20652193
	3	(β_3)	1 971185729 B	8 45	0 0001	0 23329134
	4		0 000000000 B			
BEF_AFT	0	(β_4)	-0 222869049 B	-0 97	0 3334	0 23034014
	1		0 000000000 B			
TOOL*BEF_AFT	1 0	(β_5)	2 539084884 B	10 45	0 0001	0 24303519
	1 1		0 000000000 B			
	2 0	(β_6)	1 135467352 B	4 58	0 0001	0 24795180
	2 1		0 000000000 B			
	3 0	(β_7)	1 516383092 B	5 35	0 0001	0 28363517
	3 1		0 000000000 B			
	4 0		0 000000000 B			
	4 1		0 000000000 B			

NOTE The X'X matrix has been found to be singular and a generalized inverse was used to solve the normal equations Estimates followed by the letter 'B' are biased, and are not unique estimators of the parameters