WALK-THROUGH SURVEY REPORT:

CONTROL TECHNOLOGY FOR ADHESIVES

AT

NATIONAL VENEER PLANT
BROYHILL FURNITURE INDUSTRIES, INC.
LENOIR, NORTH CAROLINA

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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
Division of Physical Sciences and Engineering
Engineering Control Technology Branch
4676 Columbia Parkway
Cincinnati, Ohio 45226

PLANT SURVEYED:	Broyhill Furniture Industries, Inc. Lenoir, North Carolina 28633
STANDARD INDUSTRIAL CLASSIFICATION CODE:	2435, Hard Wood Veneer And Plywood 2436, Softwood Veneer and Plywood
SURVEY DATE:	September 1, 1982
SURVEY CONDUCTED BY:	Vincent D. Mortimer, Jr. Bruce A. Hollett
EMPLOYER REPRESENTATIVE CONTACTED:	MR. E. D. Beach, Vice Chairman Broyhill Furniture Industries, Inc. Mr. Bill Sales, Manager Engineering Department Mr. Scott Ross, Manager, National Veneer Plant Mr. Raymond Harris, Personnel/ Safety, National Veneer Plant
EMPLOYEE REPRESENTATIVES CONTACTED:	None
ANALYTICAL WORK PERFORMED BY:	CEA Operation: Robert Phillips, NIOSH/IWSB Badge Analysis: Eugene R. Kennedy and James Arnold, NIOSH/DPSE XAD-2 Tubes: Young Hee Yoon, UBTL, Salt Lake City, Utah

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH)is the primary federal agency engaged in occupational safety and health research. NIOSH was formally created by the Occupational Safety and Health Act of 1970 from the former Bureau of Occupational Safety and Health (BOSH). This legislation--which also gave rise to the Occupational Safety and Health Administration (OSHA) in the Department of Labor-- called for a separate organization, NIOSH, to provide for research and education programs related to occupational safety and health. An important area of NIOSH research deals with methods for controlling occupational exposure to potential chemical and physical hazards.

This research study began as an assessment of occupational health hazard controls associated with the industrial use of adhesives. Plants in the aerospace, automotive, footwear, wood products, and some other industries were visited to observe the relation of the workers to the use of adhesives in the manufacturing processes and the type of controls being used. This preliminary work identified hot-process veneering with urea-formaldehyde resin adhesives as the operation which could benefit most from control technology research.

Formaldehyde, a commonly used substance in industry and the life sciences, has long been recognized as a potential irritant of the eyes nose, and skin.[1] In the last few years, the results of some animal toxicity studies have shown a relationship between formaldehyde exposure and cancer in some laboratory animals. It is not known how long it will be until the risk of cancer for humans exposed to formaldehyde can be determined. In the meantime, as a prudent public health measure, plants should reduce occupational exposure to formaldehyde as much as possible with engineering controls and work practices.[2] However, little information is available on the relative effectiveness of available methods for controlling exposure to formaldehyde in wood panel manufacturing.

In response to this need, the Engineering Control Technology Branch of NIOSH is studying the control of formaldehyde emissions from heated-process veneering operations which use a urea-formaldehyde resin adhesive. The goal of this study is to evaluate a number of different approaches which some furniture/wood products manufacturing firms have taken to control these emissions, and then to disseminate useful information and practicable recommendations of effective methods for controlling occupational formaldehyde exposure.

The research will be conducted primarily by performing a series of in-depth field surveys. This preliminary survey was conducted on September 1, 1982 to assess the potential of the operations and associated controls for inclusion in the in-depth study phase of the project: The following report documents the information pertinent to that assessment.

PLANT DESCRIPTION

The National Veneer plant is located on Virginia St. in Lenoir, North Carolina. It has been in operation since the 1920's. This plant has a complete veneer manufacturing process including cutting the veneer from the logs. They manufacture laminated wood panels and parts. The plant currently employs 89 production workers. Housekeeping is performed by the operating crews for their own area. Maintenance is accomplished by a plant wide maintenance shop.

ENVIRONMENTAL HEALTH PROGRAM

The company provides an annual hearing and vision examination. No other physical examinations are required. Environmental surveillance has been provided by their insurance carrier; however, formaldehyde control has not been evaluated in the past. Employees are trained in first aid and a nurse is available at the corporate headquarters building nearby. Health and safety training are provided on the job by each department. Personal protective equipment provided are gloves and aprons. Employees are encouraged to wash their hands whenever they have contacted glue.

PROCESS DESCRIPTION

The RF press activity was moved to its present location from another plant eight months prior to the survey. These presses have been moved twice since

Broyhill began using them 25 years ago. The ventilated enclosures were moved with the equipment. The three presses are operated by 11 employees. Two of the 13-ply presses operate from the same control unit, which reduces the effective overall maximum production rate to about 2-1/2 presses. They produce about 1,500 square feet of panel per day per press. The production is divided about 40 percent, 13-ply and an equal percentage of 7-ply, with the remaining 20 percent ranging from 5- to 13-ply.

The majority of the plys are alternate layers of gum and poplar with a maximum thickness of 1/8 inch. The resin used is Borden CR5H which is specified to contain no more than 5 percent free formaldehyde. The parts are layered in forms under approximately 200 psi applied pressure. The RF power is generated for a variable period, determined by the amount of glue line, ranging from 2 to 4 minutes followed by a cool-down/glue setting period of 1 to 2 minutes.

The duties of the press crew are mixing, spreading, laying-up panels, loading, unloading, and separating. There is one glue mixer and one spreader operator who feeds the stock through the spreader. Two workers remove the glued layers and lay them in stacks according to the thickness desired. The same workers then roll the stacks of panel stock on roller conveyors to the press input side. They load a prescribed number of layered panels in each form in the press. After the press has completed the heating and cool-down cycle, the unloading worker removes the hot panels. He places the stack on edge on the floor and leans over it, separating and checking each panel.

The plant layout is shown in a line drawing Figure 1. The overhead door and loading dock doors provided a source of replacement air in the press area.

DESCRIPTION OF CONTROLS

Each of the three presses is equipped with a local exhaust system. There are variations in enclosure face areas, exhaust plenum design, and volume of air exhausted. All three presses have doors with gridded openings which form the sides (faces) of the enclosure. They slide up to allow the operators access for loading and unloading the presses. Each press has an RF coil which is enclosed in a gridded box protruding from one end. Air is drawn from the enclosures through slots at either end. Press No. 3 has the exhaust slot in the end coil box. In addition to the local exhaust, there are pedestal fans which the workers can position to provide cooling air, and there is a wall exhaust fan some distance behind the press area. No replacement air is supplied; it is drawn in through open windows and loading dock doors.

EVALUATION DESIGN AND METHOD

The effectiveness of controls was measured by collecting time-weighted average (TWA) airborne formaldehyde samples from the press area and in the breathing zone of the operators. Short-term formaldehyde measurements were taken to assess the control of peak exposures. Performance of the ventilation system was observed by use of smoke tubes to visualize air patterns, and by measurement of face velocities at the openings of the RF press enclosures.

Personal breathing zone and area airborne samples were collected on Supelco XAD-2 Porous Polymer tubes with MDA 808 or DuPont P-200 low flow pumps at 50 mL per minute. Analysis was by NIOSH P&CAM 354.[3] This method uses capillary gas chromatography with flame ionization detection. The lower limit of detection of this method is 0.005 mg/m^3 [0.4 parts per million (ppm)] for a 3.5-hour sample period. In addition to these conventional sampling methods, DuPont and 3M dosimeter badges were also placed beside some of them. The purpose of these duplicate samples was to obtain field comparison data to aid in a NIOSH study of this type of monitoring device.

Short-term exposures were measured by the CEA-555 Organic Vapor Monitor. The CEA is a continuous monitoring colorimetric system. This system is based on a pararosaniline procedure developed by Lyles, Dowling, and Blanchard.[4] Formaldehyde is absorbed in a sodium tetrachloromercurate solution that contains a fixed quantity of sodium sulfite. Acid bleach pararosaniline is added, and the intensity of the resultant color is measured at a wavelength of 550 nm. Liquid standards were used for calibration. The CEA's standard range is 0 to 5 ppm with a minimum detection of 1 percent full scale. Its sample lag time from point of collection until it reaches the detector is 5.5 minutes. Its 90 percent full scale rise time is 3 minutes. It provides a full scale peak response over a reasonably stable observation period of 5 minutes. The response time of this analytical system is such that a short-term (less than one minute) transient peak greater than 10 percent of the full scale response will not be accurately measured.

Ventilation measurements were taken with a Kurz Model 441 hot wire anemometer. This instrument is accurate within ±5 percent.

ENVIRONMENTAL FINDINGS

Observations

Only two of the three presses in the RF lamination process were operating at the time of this survey. Press No. 1 processed 416 pieces of 9-ply, which equaled 1,433 square feet of plywood with 11,464 square feet of glue line. Press No. 3 processed 375 pieces of 10-ply, which equaled 1,301 square feet of plywood with 11,709 square feet of glue line. A total of 881 pounds of glue was used that day.

The operators on the take-off side of the presses are required to handle the hot panels which results in obvious discomfort from the peak exposures to hot formaldehyde emissions. These are typical of the work practices observed at similar panel manufacturers.

Formaldehyde Measurements

Results of the air samples are shown in Table 1. The No. 1 press unloader's personal breathing zone sample is below the lower limit of detection and is therefore less than 0.37 mg/m^3 [less than 0.31 ppm]. The No. 3 press unloader's personal breathing zone sample was just at the detection limit at 0.53 mg/m^3 [0.44 ppm]. The test badge results are presented in Table 1. Since these badges have not been validated by NIOSH, these results will not be used to assess the effectiveness of controls for this survey, but instead contribute to a separate NIOSH evlaution of passive monitors.

TABLE #1

RESULTS OF AIR SAMPLES FOR FORMALEDHYDE
BROYHILL NATIONAL VENEER
LENOIR NORTH CAROLINA

SEPTEMBER 1, 1982

LOC. #	JOB CLASSIFICATION	SAMPLE No.	PERIOD START	PERIOD STOP	TIME (min)	RATE (1pm)	VOL. (1)	XAD-2 (mg)	FORMALDEHYDE SAMPLES mg/m^3	FORMALDEHYDE SAMPLES (ppm)	DUPONT mg/m^3	BADGES (ppm)	3M mg/m^3	BADGES (ppm)
RF-3	Unloader	389	10:39a.m.	3:05p.m.	266	0.050	13.3	0.007	0.5	0.4				
RF-3	Unloader		10:39a.m.	3:05p.m.	266		13.3				1.5	1.23		
RF-3	Unloader		10:39a.m.	3:05p.m.	266		13.3						1.0	0.87
RF-1	Unloader	390	10:33a.m.	3:00p.m.	267	0.050	13.4	<0.005	<0.4	<0.3				
RF-1	Unloader		10:33a.m.	3:00p.m.	267		13.4				0.9	0.71		
RF-1	Unloader		10:33a.m.	3:00p.m.	267		13.4						0.5	0.38
RF-3	Unloader Area	392	11:10a.m.	3:05p.m.	235	0.020	4.7	<0.005	<1.1	<0.9				
RF-3	Unloader Area		11:10a.m.	3:05p.m.	235						0.8	0.68		
RF-3	Unloader Area		11:10a.m.	3:05p.m.	235								0.6	0.47
RF-3	Unloader Area	393	11:10a.m.	3:05p.m.	235	0.022	5.2	<0.005	<1.0	<0.8				
MIX	Glue Mix Area	400	11:16a.m.	2:54p.m.	218	0.060	13.1	<0.005	<0.4	<0.3				

LIMITS OF DETECTION:
(units per sample) 0.005 mg/spl

EVALUATION CRITERIA:			(mg/m^3*)	[ppm]
NIOSH	-Ceiling		LFL	
	(The previously recommended criteria for irritant properties for a 30 min. sample period was-)		1.2	[1.0]
ACGIH	-TLV	Ceiling	#A2(1.2)	[1.0]
OSHA-PEL	-TWA		3.6	[3.0]
	-Ceiling		6.0	[5.0]
	-30 min. Peak		12.0	[10.0]

NOTES:

- < Less Than --indicates that the sample was below detectable limits and if present at all was less than this air concentration.
- LFL Lowest Feasible Level
- # Recommended revision 1982.
- A2 Suspect Carcinogen.
- * For consistancy all criteria values adjusted to 25'C at 760mm Hq.

The CEA measurements (not tabulated) are generally less than 1.2 mg/m^3 [1.0 ppm] with the exception of two measurements taken near Press No. 3. One, a 32 minute source sample, taken directly over the hot wood pile is 2.4 mg/m^3 [2.0 ppm]. Another 28 minute sample taken in the work area of the Unloader is greater than 1.2 mg/m^3 [1.0 ppm].

Ventilation Measurements

The ventilation measurements for each of the three presses are shown in Tables 2A, 2B, and 2C. Press No. 1 performed much better than Press 2 or 3. This is not surprising since it has the highest volume exhaust per square foot of face opening. In addition to maintaining an overall average face velocity through the gridded door area of 140 feet per minute (fpm), it also maintained a minimum face velocity of 75 fpm. Press No. 2 had a much larger grid area to control and less than half of the exhaust volume. Face capture velocities below 75 fpm cannot be considered effective since they are on the same order as natural air disturbances and much less than the velocities from pedestal fans and workers movements. Press No. 3 has the least effective control system even though it has only half as great an open grid area. The placement of the exhaust plenum in the coil box instead of the main enclosure resulted in a much higher ventilation rate for the coil box, but at the expense of control velocity for the main enclosure grid.

CONCLUSIONS AND RECOMMENDATIONS

This facility represents a unique opportunity to observe a well defined control method at three different levels of performance on the three presses. There is the added advantage of very little interference from the surrounding work activity.

The limited number of partial shift samples taken for preliminary observations are not sufficient to make a determination of the overall daily exposure environment. From the very limited personal exposure measurements it would appear that there may be a measureable difference in the effectiveness of the exposure controls. It is also probable that with minor alterations in the effective area of the face on Press No. 2 it would perform at the same level as Press No. 1. Press No. 3 could also be altered to provide similar control characteristics although it is not clear whether the exhaust plenum would have to be extended into the main control cavity to achieve this comparability.

Based on observations of the take-off workers' activities it is judged likely that his highest peak exposure is during separation of the hot boards. With some minor alterations this activity could be modified to provide a backdraft across the hot pieces and into the hood face. This would be a most desirable achievement.

TABLE 2A. RF PRESS NO. 1, NATIONAL VENEER, SEPTEMBER 1, 1982
TAKE OFF SIDE FACE VELOCITY MEASUREMENTS (FPM)

180	160	100	120	190	220	
190	140	80	130	160	200	Height
175	120	160	140	150	220	(in.)
120	130	150	120	175	175	42.0
		Width (in.)		78		

Eff. Width (ft.)= 6.5 Eff. Height (ft.)= 3.5

Avg. Face Velocity (fpm) 154 Effective Area = 22.8 (sq. ft.)

TOTAL VOLUME (CFM) = 3512
(TAKE OFF SIDE)

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INPUT SIDE FACE VELOCITY MEASUREMENTS (FPM)

240	160	100	80	160	180	
210	130	90	90	100	150	Height
150	100	75	60	130	140	(in.)
130	100	100	90	100	130	42.0
		Width (in.)		78		

Eff. Width (ft.)= 6.5 Eff. Height (ft.)= 3.5

Avg. Face Velocity (fpm) 125 Effective Area = 22.8 (sq. ft.)

TOTAL VOLUME (CFM) = 2839
(INPUT SIDE)

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THREE SIDES OF COIL BOX FACE VELOCITY MEASUREMENTS (FPM)

20	30	30	40	5	15	
60	60	30	20	15	5	Height (in.) 18.0
		Width (in.)		54		

Eff. Width (ft.)= 5 Eff. Height (ft.)= 1.5

Avg. Face Velocity (fpm) 28 Effective Area = 6.8 (sq. ft.)

TOTAL VOLUME (CFM) =
(COIL BOX) 186

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TOTAL VOLUME EXHAUSTED FROM PRESS #1 6537 CFM

TABLE 2B. RF PRESS NO. 2, NATIONAL VENEER, SEPTEMBER 1, 1982
TAKE OFF SIDE FACE VELOCITY MEASUREMENTS (FPM)

80	50	50	60	45	75	
60	50	60	60	50	60	Height
90	50	40	40	50	50	(in.)
120	50	30	40	50	50	48.0
	Width (in.)			102		

Eff. Width (ft.)= 8.5 Eff. Height (ft.)= 4.0

Avg. Face Velocity (fpm) 57 Effective Area = (sq. ft.) 34.0

TOTAL VOLUME (CFM) (TAKE OFF SIDE) 1927

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INPUT SIDE FACE VELOCITY MEASUREMENTS (FPM)

30	30	10	5	30	40	
30	20	5	10	10	50	Height
50	20	10	5	5	5	(in.)
25	20	5	10	10	10	48.0
	Width (in.)			102		

Eff. Width (ft.)= 8.5 Eff. Height (ft.)= 4.0

Avg. Face Velocity (fpm) 19 Effective Area = (sq. ft.) 34.0

TOTAL VOLUME (CFM) (INPUT SIDE) 630

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THREE SIDES OF COIL BOX FACE VELOCITY MEASUREMENTS (FPM)

10	20	10	20	50	25	
20	30	20	10	25	50	Height (in.) 18.0
	Width (in.)			48		

Eff. Width (ft.)= 4 Eff. Height (ft.)= 1.5

Avg. Face Velocity (fpm) 24 Effective Area = (sq. ft.) 6.0

TOTAL VOLUME (CFM) (COIL BOX) 145

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TOTAL VOLUME EXHAUSTED FROM PRESS #2 2700 CFM

TABLE 2C. RF PRESS NO. 3, NATIONAL VENEER, SEPTEMBER 1, 1982
TAKE OFF SIDE FACE VELOCITY MEASUREMENTS (FPM)

75	50	65	55	
60	65	55	55	Height
60	45	60	50	(in.)
50	60	50	50	34.0
Width (in.)			68	

Eff. Width (ft.)= 5.7 Eff. Height (ft.)= 2.8

Avg. Face Velocity (fpm) 57 Effective Area = 16.1 (sq. ft.)

TOTAL VOLUME (CFM) 908
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INPUT SIDE FACE VELOCITY MEASUREMENTS (FPM)

10	15	10	50	
5	20	10	40	Height
50	30	10	25	(in.)
15	20	10	20	34.0
Width (in.)			68	

Eff. Width (ft.)= 5.7 Eff. Height (ft.)= 2.8

Avg. Face Velocity (fpm) 21 Effective Area = 16.1 (sq. ft.)

TOTAL VOLUME (CFM) 341
(INPUT SIDE)
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THREE SIDES OF COIL BOX FACE VELOCITY MEASUREMENTS (FPM)

220	120	130	250	Height
200	140	140	200	(in.)
				15.5
Width (in.)			33	

Eff. Width (ft.)= 3 Eff. Height (ft.)= 1.3

Avg. Face Velocity (fpm) 175 Effective Area = 3.6 (sq. ft.)

TOTAL VOLUME (CFM) 622
(COIL BOX)
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TOTAL VOLUME EXHAUSTED FROM PRESS #3 1871 CFM

REFERENCES

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4. Lyles, George R., Fred B. Dowling, and V. J. Blanchard: Quantitative Determination of Formaldehyde in the Parts Per Million Concentration Level. JAPCA 15(3):106-108 (1965).